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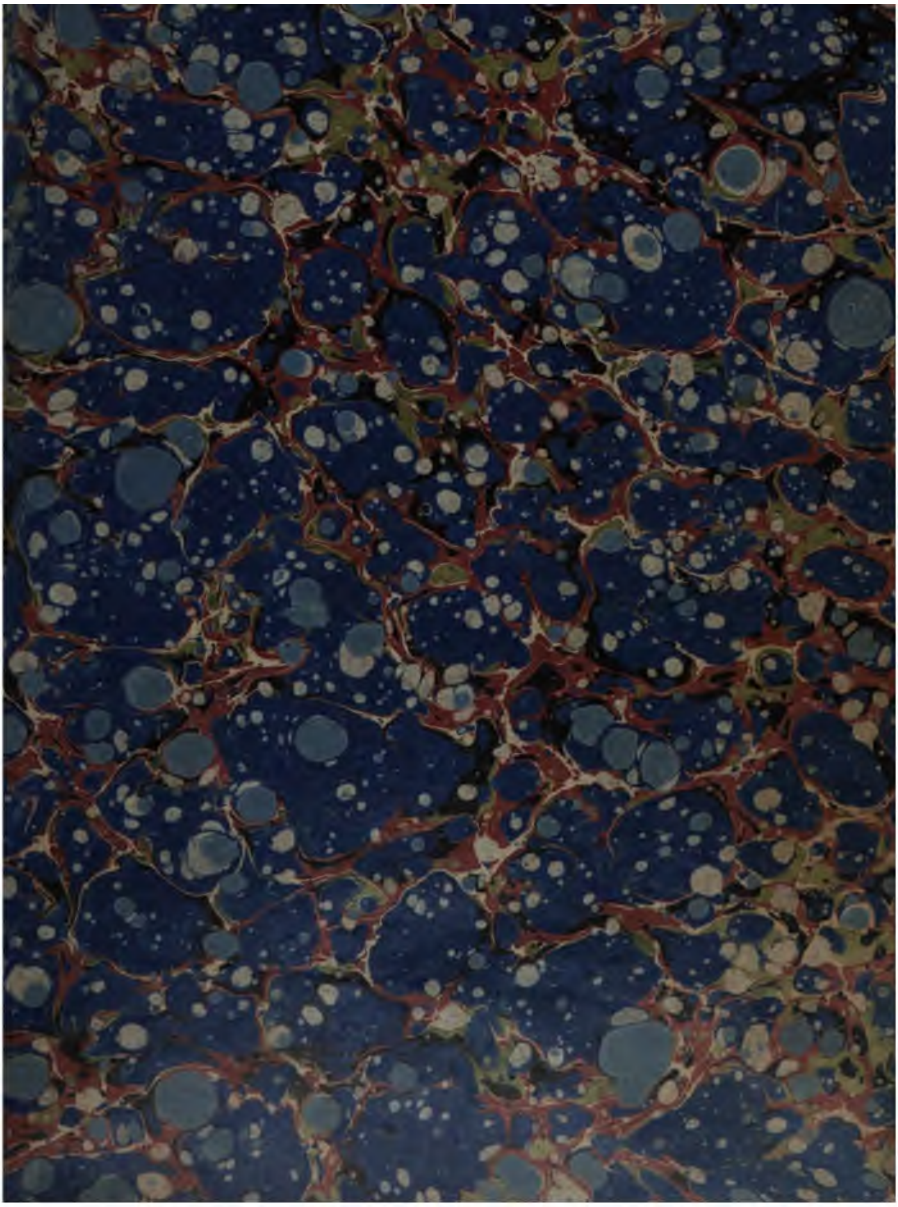

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POSTHUMOUS TRACTS,

NOW FIRST TRANSLATED FROM THE LATIN

OF

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ADVERTISEMENT.

For an account of the *MSS.* of Swedenborg in which these *Posthumous Tracts* are found, the reader is referred to the Latin Edition of them, just published by the Swedenborg Association, and edited by the Translator of the present volume.

The way to a knowledge of the Soul.

Several years have now elapsed since I first conceived the design of working out the problems of *rational psychology*, or what amounts to the same thing, of investigating the essence and faculties of the human soul and internal senses; but hitherto the extreme difficulty of the subject, coupled with the vast amount of preliminary knowledge which is requisite, have warned me against treading prematurely in this direction; for much must previously be reduced to a clear statement and a distinct order. Certain it is, that those who are but superficially informed in the elements of the sciences, or even well acquainted with one or two separate branches of knowledge, and who notwithstanding are rash enough to enter upon this field, in consequence of their ignorance of many and in some cases of the leading means, will but exert an unprofitable subtlety for the most part on empty questions, and only discuss ingenious trifles; and according to their natural endowments, and the manner in which these are cultivated and enlightened, or as it often happens, obscured by the few sciences which such persons possess, they will involve grave truths in thorny discussions, which can have no effect upon the brains, but to occasion differences and quarrels, which no judge is competent to settle, from the trivial nature of the matter upon which the acumen and subtlety are expended. The present subject, however, is too important to be so treated: it is no arena for foils, but for naked weapons. To complete the single science of the soul, all the sciences are required that the world has ever eliminated or developed. If any shall undertake the task with less than all, it must be with the certainty of discovering in the end that he is destitute of the instruments, and unequal to the toils, of so vast a work. The points which he requires, but of which unhappily he is ignorant, he must perforce obtain from himself or coin from his own mind, that is to say, he must use the imagination to supply the place of real knowledge; and how prone to error the imagination is if left to its own guidance, without the continual advice of experience, and the precepts of a true philosophy, is perfectly well known to even the least instructed. Let the reader only make the attempt for a short distance, and he will soon find himself retreating with his standards, and obliged to bring up fresh forces, before he can profitably return to the field where the peculiar battle must be won.

If we wish to deserve success in the study, it will in the first place be necessary to spare no pains, but to exert the mind to the utmost, in clearing and winning those particulars which closely surround and are subordinate to the subject in hand. The anatomy of the body, the anatomy of animal bodies in general, and especially of the cerebrum, cerebellum, medulla oblongata and spinal marrow, and also of the nerves, must open the avenues which lead to it. Without a thorough command of these portals, it is in vain to hope to penetrate the recesses of nature's temple. It is impossible to divine what nature is in the invisible sphere, excepting from what she is in the visible; or what she is in causes, excepting from what she is in those effects which ultimately strike some one of the senses. Just so it is impossible to know the nature of the inner action of the mind, without examining the face of the mind, that is to say, without investigating the brains and marrows of the mind. And even then it will still be impossible to guess how the soul unfolds her powers, without having studied the relations and connexions of all the viscera of the body,* as well as the organs of the external senses, which contribute in their degree to enable those of the internal senses to undergo that development which will open them to the soul.

"Nature exists in totality in the smallest objects," as Malpighi well observes in his Treatise on the Silkworm.* Whatever is presented to the eyes and to the organs of the other senses, consists of series of things beginning with the smallest, and multiplied through many degrees or stages, and which at length, after they attain to a certain considerable magnitude, appear to us as the least of things; in consequence of which it is usual at first to regard them as boundaries and causes, though far from being this, they but hide or mask real causes. For this reason, no further assistance is to be expected from them, than as supplying the mind with ultimate effects, from which it may pass to principles by an analysis of its own; besides which they are the only means that the mind can judge from *per nexum* or by relation. The path however is difficult and steep. If we confine ourselves to a few facts and phenomena, we form an idea of causes in conformity with these alone; though nothing is gained or proved, unless all the facts which surround the subject both nearly and remotely, are also in accordance, and give their consent to the same effect. And when the truth is found, consent is never absent, for truth wins the suffrage of all phenomena. All things in the world are connected, because all things spring from a single most universal principle. Hence the truth on no subject can be said to be declared, unless all things eagerly confirm it. And thus whatever results we are now to arrive at in treating of the brain, must be confirmed by all that depends upon the brain, that is to say, by the whole body, including all the viscera, organs, parts, solids and fluids; also by the records of disease, whether of the body or the mind; and furthermore by the details of experimental chemistry and physics, and the entire cohort of the other arts; inasmuch as animal nature in her domain passes in the most perfect manner through all the arts to obtain the effects that she desires. Such is the connexion of all the sciences requisite to explore the powers of the animal machine alone, that the absence of but one of them is sufficient to deprive the chain of the link which suspends it, or to leave it too feeble to bear any weight.

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* Swedenborg does not regard the brain as a part of the body, but by the viscera of the body he means those of the chest and abdomen.—*(Tr.)*

Nor is it enough to acquire a knowledge of all the sciences, or even of rational philosophy in its various departments, unless we can reduce all things to higher and higher generalizations; or of all the sciences form one science, sufficiently comprehensive to embrace all. The one science to which we allude, and which we denominate the Mathematical Philosophy of Universals, although hitherto unknown to the world, is still of possible attainment: and it is our wish, if ease and tranquillity of mind be granted, ourselves to lay its foundations. Without its assistance, it is idle to hope to arrive at a knowledge of the soul; for this science is the philosophy, not of the mind, but of the soul (the mind is to be developed up to the soul, which latter admits of no development); in other words, it is the analysis whereby the soul comprehends its own objects. As however this science, as we said before, is altogether unknown, and it will therefore perhaps be thought fruitless to endeavor to acquire it, so before we give a statement of its principles, we shall by no means venture dogmatically to declare its use; but shall be content with observing, that without its help it will be easier to reach the moon than to explore the soul.

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* "Cum enim tota in minimis existat natura, si alicubi, magis equidem in *insectorum* moleculis id deprehendi par fuerit." *De Bombyce*, p. 1, fol., Londin., 1687.—*(Tr.)*

FAITH AND GOOD WORKS.

Faith and Good Works.

THERE can be no doubt that it is faith which saves, and not works separate from faith; but, where there is a possibility of doing good works, the question is, *whether faith will save without them*, according to the dogma of the Lutherans. We reply that the affirmative seems compatible neither with the divine word of revelation, nor with human reason; both of which lead rather to the conclusion, that *faith without works is a nullity; and were it anything, would condemn, not save.*

First let us hear the *Holy Scripture*. Our Savior inculcated nothing more zealously, than the duty of loving our neighbor; for he says that whoever does not love his neighbor, cannot love God, which amounts to saying, that he who does not do good works cannot have faith. In the sermon on the mount, the sum and conclusion of the whole is this, that the tree which bringeth not forth good fruits, is hewn down and cast into the fire; for the tree is known by its fruits. In pronouncing the sentence of the last judgment, he says that the wicked are to be sent into hell, because they received not the stranger, clothed not the naked, and fed not the poor; but those who had done these good works, he admits into heaven. All his teaching abounds with similar instances; as in the parable of the ten virgins with the oil in their lamps; in the parable of the sower; of the talents; &c., &c., &c.

The apostles testify to the same effect. John, in his epistle, urges almost exclusively the duties of love to God and the neighbor; upon which, as Christ himself teaches us, hang all the law and the prophets. James makes open protestation of the heinousness of faith without good works, and describes it as devilish. So also the rest of the apostles. Paul, in his epistle to the Romans, says that *it is faith which saves*, but not actions, meaning thereby, not actions without faith; but Luther, in his translation of the Bible, has added to the words of the apostle, "faith *without works*," though the latter phrase is not to be found in the sacred text; and I believe that Luther never committed a greater sin than when he made this interpolation: but God be the judge. Certain it is, that on examining and weighing all the grounds, it must appear, that faith without works is rather condemnatory than saving. Let us see therefore the meaning of the several terms, *action*, *will*, *principle of the will*, *faith*, and lastly, *love*.

Action is nothing but the execution or effect of the will, or it is the will itself at work. Separately considered it is no more than a mechanical thing, inasmuch as it is bodily or corporeal, and nearly resembling the effect of a machine; but the essence of the action is the will in the effect; so that action may be called perpetual will, much as motion is called perpetual effort by writers on physics. In man therefore will and action are coincident, since for action to be, will must be involved in it as an essence. Similar actions, or even the same action, may consist with a different will; and similar wills, or the same will, with a different action; in the same way as a similar motion may proceed from different efforts; or as the effort may be similar, and yet a different motion may result from it; for resisting media and circumstances determine or difference the motion resulting from the same effort. But to return to action; it is evident in all our human societies, that action is not regarded as action, but as will. Suppose that three men profess the same veneration for a monarch, all prostrating themselves at his feet, or bowing to the ground in his presence, or lauding his virtues to the skies; but one, with the will or wish to deceive him, the second with a view to his own reward, the third, to display in a befitting manner the honest veneration of his heart. The action of all three is the same; yet it is not the same when viewed from the will, which is heterogeneous or different in each. Therefore when the king has discovered the will of each, he hates the action of the one, and loves that of the other;

and his hatred for the former is all the greater, in proportion as the action nearly assimilates to the action of those who display the outward signs of a real inward veneration. Nothing therefore is here considered in the action, gesture, motion of the body, or speech, but the will alone; which shews that action may properly be termed perpetual will, as motion may be termed perpetual effort.

The *will* also proceeds from principles, or from a principle, of its own, as action proceeds from will. There may be different principles to a single will, as different wills to a single action; in which respect the principle is considered as determinant and efficient, and the action as the determinate and effect; the will being the mean between the two. Therefore action is no other than the principle alone; for the cause of the cause is also the cause of the thing caused. Thus relatively action is nothing but a mechanical thing, like the motion of a machine; and the will is like the effort in the motion; and it is the principle alone which constitutes the essence of action, because it constitutes the essence of will; for by the common rule, there are all the essentials in effort that there are in motion, or what amounts to the same, there are all the essentials in will that there are in action. We repeat then that the principle is the only thing that constitutes the essence of action, because it constitutes the essence of will. Hence in civilized life all actions are examined and estimated by their *principles*, or in other words, by their intentions, or the ends for which they are willed and done. Moreover in common discourse the word will is used synonymously with principle or intention, being regarded as an identical term. Will, however, is the distinctive property of man, who alone is privileged to will from antecedent principles, or from a foregone intuition of ends: it does not exist in the brute creation.

The word *principle* implies whatever determines the will, and gives it a characteristic quality. There are principles which are *physical*, that is to say, proper to the body and the blood; such are the different affections of the animus, the pleasures of the same, the allurements of the external senses, the delights of the world, &c. There are also *rational* principles, or principles that regard an end, and which relatively thereto, viewed in conjunction with means, determine and enter the will, which thenceforth is properly denominated will. Again, there are principles that govern the will, which may be called *divine* principles; where the end that should determine the will to action is too ulterior to terminate in this life. This principle, however, belongs to a higher degree, and is of a sublimer character; for it does not depend upon ourselves, and it governs all other principles; so that indeed it must not be considered as a principle, but as a superior will. Yet as it ultimately enters the human will, and determines it, so it may be designated as a principle ascribable to God.

Faith is that peculiar faculty in man whereby he believes in Almighty God, in Christ the Savior of the world, and in all that the revealed Word of the Sacred Scripture dictates: consequently it is a principle of the will, but divine, or ascribable to God alone. When faith as a principle enters the will, and thereafter the action, then the action is not considered as action but as faith.

Love exactly keeps pace with faith, for whoever has faith amounting to confidence in God, has also the accompaniment of love as inseparable from faith; for the grace of God is universal, in that when He gives faith he also gives love, and the love increases in the same degree as the faith; and when the faith is conjoined with love, it then for the first time constitutes saving or true faith. Historical faith, however, is only the science or knowledge of what really is, and even the devils have it, for they know that there is a God Who is such as He is described in the Holy Scriptures: but this cannot justly be termed faith, but knowledge. We must therefore separate this meaning of faith, which arises entirely from the double signification of terms, from saving faith, which is faith conjoined with love. Thus faith and love are in these respects one, for granting the one, the other is granted also; and notwithstanding that each appears to be distinct, yet the two are so united, that God gives love in the same degree as faith; and with love, confidence; and with confidence, veneration, and acknowledgment of his grace. Thus as love is the principle of the will, so it is the essence of action.

Let us now argue on these premises. What then is will?—

When one can do what one wishes. And what is endeavor?—When the subject can effect what it endeavors. It may be called will and endeavor when doing and effecting are impossible; but if the means of doing are conceded, and no action takes place, will and endeavor cannot be accounted real, but rather are mere abstractions. To take a vulgar illustration. We may say that this tendon possesses an elastic power, or an endeavor to recover itself after being flexed; and so long as resistance hinders, it is in a perpetual effort and *nisus* to act or react. But when it has the power and opportunity to act, and yet does not act, what endeavor or elastic force has it? It is clear that it has none; and this from the fact, that it does not act when the removal of all resistance enables it to do so. And if it can, and does not, it is a sign that it counteracts its own endeavor, and has in it principles contrary to the endeavor, or which restrain, and destroy, its elasticity. Consequently, when it does not act, elasticity or endeavor cannot be predicated of it, or if predicated, the elasticity must be regarded as destroyed by a contrary principle. The same holds of faith and action. Faith is a principle of the will, and the will is the principle of action. If action does not ensue when it can, what becomes of the will? It is either an abstraction or nonentity, or else it is influenced by a principle opposed to faith. The tree then is known only by the fruit, and faith by works, according to the impressive words of our Savior and the apostles; but not by itself without good works; for this is contrary to the Word of God.

This may be illustrated still more adequately by other than merely physical similes, like that which we lately borrowed from the tendons; thus it may be illustrated by love, friendship, and an infinity of other affections, which enter the will, to constitute its principles. The simile already adopted is however sufficient, as being of a physical character, it the better impresses the senses, which are within the sphere of physics. For this reason it is that comparisons derived from trees, from oil, from seed, from fields, and from feasts, are made use of to illustrate the same subject in the Holy Scripture. The comparison is more closely appropriate than at first might be supposed. Indeed the will cannot be more fitly compared, than with endeavor, and action, than with motion. Only add living force, which is the predicate of the soul, to endeavor, and you have will; and by adding the same to motion as an effect, you have action: and so forth.

It follows therefore, that the doctrine that *faith without works saves,* is contrary to reason; but that the doctrine that *faith in works saves,* is in conformity to reason. In a certain sense indeed it may be true, that *faith saves, and not works,* that is to say, if the works are regarded as separate from faith, for then, theologically, they are not good works. Also that *true faith saves, when there is no power or possibility of doing good works.* For in this case the will of the faith may be compared to an endeavor which cannot pass into act, on account of the resistance being equal to the effort put forth by the subject: like the elasticity of a flexed tendon, which constantly reacts, or tends to act, but there may be a resistance equal to the endeavor, which restrains it from acting. However, as soon as the resistance is removed, or the impossibility subtracted, action takes place. It will indeed rarely if ever happen that saving faith will find it absolutely impossible to act; provided it clearly endeavors to act, removing as it were impossibilities; in which case that one mite which the poor widow casts into the treasury, will be of more avail than the golden gifts of the rich. Moreover God supplies possibilities to prove our faith; possibilities fitted to individuals; thus he allowed Abraham to offer up his son; to say nothing of numberless other instances which are to be found in the Sacred Scriptures.

There is then no doubt remaining, that love to God involves love to the neighbor. Love to the neighbor is identical with the performance of good works, or with loving him in reality, that is to say, with performing towards him the duties of love, without which love is a nullity. In the same way self-love not only involves wishing well to oneself, but also doing well. Therefore if instead of love to the neighbor we make use of its equivalent or value, namely, the performance of good works, we shall find that saving faith, which cannot be separated from love to God, necessarily involves good actions, or the actual exercise of love to the members of the society in which we live. It is all the same whether it be to those who are loved by God, or to those who are not loved. For it is impossible to say who are loved by God, and who are not; for a good soul may exist in a bad body; and *vice versâ;* as there are many examples to shew. To judge of others therefore belongs to God alone, and not to us; wherefore God has said, "*Judge not, that ye be not judged.*" Thus if from a principle of love to God, or from true faith, we only do our duty to our neighbor who has need of our services, we have done enough; and we have no right to be partial in our benefits, as if one individual was more loved of God than another; for in such a judgment we are almost sure to be deceived. Our province lies in judging of actions, with a view to the conservation of society; but it is reserved for God to judge of the principles of action. It is assigned to us to pronounce sentence on our fellow men, and to condemn the body to merited punishment, or even to death itself; but the soul is always left to the judgment of the omniscient God.

The *conclusion* is, that there is no love to God if there be none to the neighbor; or that there is no faith, if there be no works; and that if there be love or faith apart from works, they are destroyed by various principles contrary to the love of God and to genuine faith; and in this way love and faith are what condemn us. Therefore *faith without works* is a phrase involving a contradiction; a phrase in which the predicate ignores the subject; a position of something from nothing, of the possible from the impossible; a distinction inadmissible in this life. In the future life, love to God may be said to exist without the performance of the duties of love to the neighbor. True; but in this case love and faith are not considered as saving; for the soul is already either saved or condemned; and all the means, which consist in doing the duties of love to the neighbor,* are taken away, because the body, which is the subject of action, is extinct. Therefore sumptuous Dives wished to return to life, that he might be able to minister to poor Lazarus.

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* But on this subject see the author's work on *Heaven and Hell*, on the Occupations of the Angels in Heaven, where it is shewn that "every one there performs a use; for the Lord's kingdom is a kingdom of uses." Also that in heaven there are ecclesiastical, civil and domestic uses; and that the employments there are too abundant for enumeration, those on earth being few in comparison: furthermore that man after death is in a perfect human form, and possessed of *all the senses*, memory, thought, and affection, that he had in the world; and that when he enters the other life, he is in a body, as he was in the world.—*(Tr.)*

THE RED BLOOD.

N.B. The Blood contains all organic forms from the primary spiritual to the ultimate angular, and in this respect is the compendium and complex of all the forms of nature.

THE RED BLOOD.

CHAPTER I.

The blood is that thick, red, heavy humor which circulates through the heart, arteries, and veins.

The blood is palpably distinguished from the other humors of the body by its redness alone. The vessels through which it runs are the arteries and veins. The heart, comprising the two auricles and the two ventricles, is the first and last term, or the starting point and goal, where both the blood and the vessels meet. The circulating current runs from the left ventricle of the heart to the great artery or aorta, and to the lesser arteries; from the arteries to the smallest veins, and to the grand vein; from the veins to the right auricle and ventricle of the heart, and thence, through the lungs, to the left auricle. This circle and gyre constitutes the great sphere of the heart; and the vessels collectively constitute the arterial and venous system, or the heart in the largest sense; for the heart is as it were most present in every point of all the arteries, and in every point of all the veins; the vessels being its channels of determination, or rays of operation.

CHAPTER II.

The parts of the genuine or red blood are spherical in shape, and consist of globules surrounded with serum.

The fluid mass which gushes out when a vein is opened, is all denominated blood; but the pure and genuine blood is distinguished by its intense redness. The blood is surrounded by a serum or water of various degrees of pellucidity, and which is sometimes turbid, gray or glaucous, yellow, brown, or greenish, and full of saline and urinous elements. We are here, however, speaking only of the pure and genuine blood, which consists of round globules, as shewn by the microscope. The figure of the blood particles was unknown to the ancients; their internal form or structure is even now unknown to us; it begins however to be somewhat plainer, from the revelations of the microscope; although obscurity still preponderates. Nevertheless, we know enough to enable us to judge from what we see, of the other particulars which are beyond our vision.

CHAPTER III.

Each blood globule contains within it, and carries in its bosom, details more numerous than the eye can ever discover, or the mind conceive.

There is abundant experience at the present day, to prove that the blood globule is not uniform, simple, or devoid of parts. Indeed it admits of resolution or disintegration. In the capillaries it actually divides into lesser globules, and these into least, which are so minute as to escape our vision. When the blood is exposed to a moderate heat, and so distilled, it is converted into an ardent spirit, with oils and phlegm; moreover when the globule is resolved, it yields a large quantity of volatile salts, which crystallize under the form of a regular vegetation. The more considerable parts which come over, are shewn by the microscope to consist of triangular and square corpuscules. To this extent the high experience of microscopic vision has really penetrated. And we may augur from it, that details more multiple and more perfect still, lie hidden in the lesser globules, and again in the least. These however we cannot expect to see distinctly, for we are unable to see the globules that contain them; as when we cannot see some small insect, which equals only the minutest ray of microscopic light, it would be in vain to expect to see its little viscera, or the structure of its exquisitely fine members. Now the case is the same with the blood-globule; although from what we have found and know it is sufficiently certain, that if all its contents could be discovered, and if it could be magnified to the size of the human brain, an infinity of new details would come to light, and nevertheless an infinity would still remain unseen. For the blood is the repository and the seminary of all things in the body, and contains in act whatever has preceded it in the kingdom, and in potency whatever comes after it, or will come after it. For this reason it is, that the universal body is sick when the blood is sick, and *vice versa;* and that in the greater number of diseases, it is sufficient to find a medicine for the blood alone, to restore the body to health.

CHAPTER IV.

The red blood globule admits of division into six lesser and pellucid globules.

Six lesser globules have been actually seen in one large blood globule; and indeed the mode in which they are united, and the relative position which they occupy to each other, have been described and drawn, and wax models representing the whole have been constructed. Moreover, the several lesser globules have been seen in the act of separating from the compound body; in which case their pellucidity was manifest, and as they came away from the red globule, they were observed to penetrate the capillary vessels. Furthermore experience has shewn, that these prior or simpler globules are themselves divisible into still lesser ones, and even into least, where sight can follow them no longer. All these particulars must be received as true, because the observer,* and the witnesses to his observations, are worthy of credit. Now as the parts of the red blood admit of division into simpler parts, it follows that the latter, which are the prior and simpler constituents of the blood particles, are not the red blood, but constitute a purer, inner, and more perfect blood. The change in color will not alter the essence, nor consequently the name. Like the red blood, this pellucid blood circulates through vessels, and pursues its course where the grosser fluid cannot follow. We therefore term this humor, which consists of pellucid spheres, the purer or middle blood.

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* Leeuwenhoek.—(*Tr.*)

CHAPTER V.

In the red blood globule there are also a number of saline and urinous particles, of different shapes.

Besides the lesser pellucid globules which constitute the large globule of the red blood, there are also in the blood, certain angular, or saline and earthy parts. These also have been seen and described, yet only those that are square or cubical; the others perhaps being too minute for observation. It may however be inferred that each red globule contains triangular as well as cubical forms, from the consideration, that when the six lesser globules are in their full whirl and speed of fluxion, they could not cohere together, were there not intrinsic means provided to strengthen and hold them in combination. The blood globules are flexible and soft, and capable of being extended in length to two or three times their diameter. And although they admit of being extended, and even divided, yet they are all of equal size. Which is a plain enough proof, that they have some fulcrum, support and stay, to ensure their cohesion under the compound form. The particles of salts, both the primitive and the compound, are angular forms; that is to say, they are inert and figured, or consist of extremely minute trigons and cubes, hollowed out so as exactly to fit the convexity of fluent and active parts; being made and formed with a view to combining or copulating with round particles, which are the genuine parts of motion; to temper and moderate their activity, and to cause them to combine further, by successive degrees, into new and more compound forms. Th der that the six globules may unite and cohere in have a little cube in the middle with six sides and eight angles, and with each of its sides hollowed out: and if any humor, however intense its fluxion, comes into the mould of these hollow sides, it will of necessity fall into globules, each of a size and convexity answering to the size and concavity of the side. But to make the globules firm and tight, still other and lesser parts, and these of a triangular form, must be fitted to the several angles or angular interstices, of which there are eight; and when these triangles are properly inserted, the whole will then be a stable compound. The cube in the middle which serves as the basement or stylobate of the compound globule, is no other than a particle of common salt. The triangular forms are volatile and urinous salts. Of the latter the ardent spirits are composed, as well as all the various species of oils which the blood yields on distillation. Particles of the kind float about in the serum, and are thereby supplied or offered to the blood. And that these are indeed the constituents which escape in large quantities from the blood when it is resolved or disintegrated, is clear from the crystalline vegetation which they then go to form; also from the little cubes that have been observed, when this process takes place; and from similar cubes being found in the caput mortuum after blood is distilled. And further from the consideration, that without an application of parts like what we have mentioned, composition would be impossible; and above all, the red blood could never be the repository of the humors which precede it, and the seminary of those which follow it. On the other hand, by the mutual application of the triangular, cubic, and round forms, we have not only a firm and coherent globule, but one which is spherical, voluble, flexible, fluid, adapted to any straitness of passage, soluble, ruddy, heavy, warm, and embracing the prior elements of the whole mineral and vegetable kingdoms; all of which in a moment spontaneously glide into one to form it, and it holds and keeps them all on the happiest terms of mutual compact, and arranged in the most admirable order; while the spirituous substance, which resides in the lesser globules, is the single principle which reigns in the assemblage.

CHAPTER VI.

The redness of the blood arises from the interposition in each globule of salino-volatile particles.

If in the middle of the blood globule there be a stay or fulcrum consisting of a little cube with six sides and eight angles, and if each angular interstice which is left between the lesser globules, have minute trigons and cubes inserted in it, that is to say, salino-urinous particles—in this case it is impossible that redness should not be produced. Color is the modification and variegation of the rays of light, and the red species cannot fail to arise, wherever the rays pass through an object thus regularly interpolated with trigons and cubes; for as they fall,—as they are incident,—they penetrate with perpetual refraction to the little cube which fulfils the place of a centre, and there undergoing repercussion, they gyrate with a giddy whirl around the lesser globules which lie at the sides. Thus much is known with certainty, that nothing produces the various kinds and forms of shaded light with greater distinctness or in more exquisite purity, than volatile, urinous and alkaline salts, or than sulphurs, inasmuch as all these are in reality triangular corpuscules, or prisms and quadrangles, excavated laterally: which when they are distributed or packed in an orderly manner so as to form a compound body, are sure to result in a general modification of light, either red, green, or yellow, and to display a surface that is really distinct and comprehensible only under the condition of a general visual perception. The result is different when the proportion of light or rather whiteness in the sphere is less, under which circumstances green or blue are generated; but yellow, when the proportion is greater. This is proved by the transmission of the solar rays through glass globes, through bubbles of water, and through steam, also through prisms variously placed; by the phenomenon of colors in those places where shade begins to be markedly discriminated by light; by various chemical mixtures and precipitations; by the whole vegetable kingdom, so richly adorned with colored objects; and by an infinity of other instances; from a careful survey of all of which it is very clear that there is nothing at all real* in color. On the same principles it is also evident why the blood is more or less red at different times and in different individuals, and why is it sometimes comparatively pale, yellow, or green, or even tinged with unseemly black.

CHAPTER VII.

The gravity of the red blood results from the same saline and urinous particles which are contained in the globules.

The red blood is heavier than water, in which when placed it sinks to the bottom. The cause of its gravity necessarily lies in parts endowed with *vis inertiæ* and resistance, as are all those which are angular and terrestrial, or which belong to the mineral kingdom. The force that determines the gravity of bodies evidently resides in the purest circumambient atmospheres, which press all points of non-elastic bodies with perfectly active force and unerring direction towards the general centre. Thus gravity or centripetency originates from cosmical substances destitute of both gravity and levity. It follows that the salino-urinous and volatile particles in the blood globules, of which we spoke above, are the proximate causes of the gravity of the blood. Therefore the quantity of these particles may be inferred from the gravity of the blood. And it would be worth while to institute a comparison between similar volumes of the red and of the purer blood. The heavier blood is for the most part harder, because impregnated with a superabundance of earthy elements; while the lighter blood is relatively soft, as well as tinged with a more grateful redness.

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* In asserting that color is not real, the author means that color is not a thing *(res)*, but the modification of a thing.—*(Tr.)*

CHAPTER VIII.

The warmth of the blood differs in different cases, and arises from different causes.

Animal life in its most essential form gives the blood its proper or peculiar heat, which is intimately latent in the fundamental constitution of all its parts; but this heat is a mild warmth, which kindly and gently fosters the viscera, and lights up the fires of all the laboratories scattered through the system, for the due performance of their various works. This is sometimes increased even to fervid intensity by the movements of the animus, or by disease of the body, and withers the parched and exhausted viscera. At other times it falls and fails, often to such an extent, that the members of the frame shiver from its absence. Thus as soon as the blood is taken from its native veins, it loses its heat, and begins to die, to be converted into clot and sanies, and to thicken into a viscid and pultaceous slime. The proper heat of the blood is then of the mildest kind; greater in youth than at other periods, and even sensible to the touch; but in its intense degree amounting to febrile ardor. But there is no keener excitant of heat than volatile urinous matters, such as lie in the bosom of sulphurs, bitumens, resins, and of various kinds of wax, oil, spirits, nitres, and vegetables. And there is nothing which more speedily and naturally promotes it, than the auras of the world, and their analogues, the spirituous fluids of the animal kingdom. By consequence heat has no readier generator than the blood, which lodges both the volatile urinous and sulphurous matters we have mentioned, and the animal spirit, entering into intimate union and consort with them. Thus the natural heat increases with the increase of the spirituous fluid, including its volatile adjuncts, as during childhood; it decreases with the decrease of the same, as in old age; it varies as the character of the blood is altered by the vast diversity of causes which affect it; it is perpetuated by the continual resolution and combination of the particles, as well as by the continual exercitation of the blood by the brains. Thus it appears that there is nothing real in heat, fire, flame, or cold, but that they are the affections and qualities of substances either vibrating and gyrating, or on the other hand, at rest.

CHAPTER IX.

The genuine blood is relatively soft, and admits of extension and division; and its softness arises from the purer and white blood which lies in the red globules.

It is now so well established by microscopic observation, that the genuine blood is soft and flexible, and may be extended in length to twice or thrice its breadth, as well as divided into parts, that no room is left to doubt of the fact. The microscopists have seen the blood globule in the capillaries compressed into an oblong or oval figure, and ultimately broken up into a number of other particles and globules. But if the proofs which instructs us of the softness, extensility and divisibility of the globules of blood, be sufficiently ample to make doubt impossible, we have to enquire into the cause of the phenomena. And here the same experience shews, that the lesser globules, of which each larger globule contains six, are the parts that yield, inasmuch as they may be drawn out till they form a kind of thread, while the larger globule only admits of being compressed. Hence the cause of the flexibility resides in the lesser globules, but not in the salino-urinous and sulphurous particles, which latter are hard, inert and passive, and only made use of as means of combination. Those lesser globules that constitute the purer blood, and those that constitute the animal spirit, are so soft and flexible as to yield to the smallest impulse, to the least assailant force. The perfection of the entities of nature's purer sphere lies in their pliability, in their suffering and doing, undergoing passion and exercising action, proportionally and correspondently; or in representing the most perfect forces of nature; which cannot be done by hardness and gravity, inasmuch as hard bodies absorb and extinguish influences and forces; while on the other hand elasticity and a yielding nature, and passive power equal to active, suffer no force to be lost, but receive it, and give it forth again in all its integrity to the neighboring parts as well as to the universal volume. Moreover, if the perfection of the purer entities consists in mutability of state, it follows that they must be soft, yielding and flexible; or active to the same degree as passive; otherwise they could not accommodate themselves to all the various forces; and the soul could neither feel, imagine, think, nor discriminate the minute differences in represented objects, which are all of them forms: neither could the animal spirit run through the fibres, and determine into act whatever the mind endeavors and wishes. Therefore the purer blood and the animal spirit, which is again a simpler humor of the animal kingdom, are the causes of the flexibility observed in the blood globules. And it is evident from this in what the composition of the blood globules consists.

CHAPTER X.

In the living body the red blood undergoes perpetual dissolution, purification and renewal.

We have shewn that the globules of the red blood are dissolved into lesser and pellucid globules; that they are recompounded or renewed follows from this, that the quantity of blood in the veins and arteries remains the same notwithstanding. This resolution and recomposition of the blood produces that circulation which we term the circle of life; a circulation from the vessels to the fibres, and from the fibres to the vessels. Thus the blood loses nothing by death or dissolution, but only in every instance returns to its first essence and nature; and from this again reverts to its general, or to its last or ultimate form. But when the compound body is dissolved, or the red blood dies, it does not cease to exist, but always returns to a purer life, and is gathered to its parent, the soul. So each moment life and death alternate in us, and every particle of the blood represents the general condition of the body. Indeed were it not for the continual dissolution and renovation of the blood, the food would be useless to the body. For fresh elements require to be constantly taken into the system to compose the blood anew, as obsolete and antiquated matters are thrown out. Therefore it is that the blood is always surrounded with an abundance of serum, to supply and offer these elements. Moreover it requires to be continually purified, to serve all the uses of animal nature, *i.e.*, to give birth to the numerous humors with which the viscera abound. Again it must be dissolved and renewed in order to be purified, and to be always in a state of fitness and adaptability; for when too hard or compact, it will yield or give out nothing, and will never open its bosom treasures. Thus the fortune and happy condition of bodily life consist in the softness and divisibility, and not in the hardness, of the blood. Whatever is vital, is soft, patient and yielding. It is the contrary of vital, if hard, sluggish and inert.

CHAPTER XI.

The globule of the red blood contains within it the purer blood and the animal spirit, and the latter, the purest essence of the body, that is to say, the soul; whereby the red blood is a spirituous and animated humor.

The blood is the repository of all the prior or purer humors in the body, and the seminary of all the posterior or grosser; wherefore it contains the prior in actuality, and the posterior in potency. The animal spirit descends from the very essence and substance of the soul; the purer or middle blood from the animal spirit; and the red blood from the purer. It is only by this succession and derivation that the soul can be present to the several parts of the body; for to be present with all, it must be involved in all in the above order. The intimate principle then that lies in the depth of the red blood, is the very essence of the soul, which in ruling and determining the blood, rules also and determines all that depends upon the blood. Unless the blood contained within it the prior animal essences, the members of the prior sphere could never provide for those of the posterior, nor the posterior be related to the prior, nor would there be any mutual respectiveness, dependence, harmony, or real correspondence. Therefore the blood is spirituous and animated.

CHAPTER XII.

The red blood partakes almost equally of the soul and the body, and may be termed both spiritual and material.

The blood partakes of the soul, inasmuch as it involves the purer blood; this, the animal spirit; and this again, the prime essence or the soul. It partakes of the body at the same time, inasmuch as it contains earthy, inert and saline particles, which give it gravity, color, a comparatively hard consistence, and other attributes, which are the qualities of mere body, and attach to material things: besides which, the blood-globules are of a circular form, and in this way also are bodily. The quantity of space which the soul and the body occupy respectively in the blood globule, may also be calculated, by comparing the internal space filled by the little saline cube, and the angular interstices containing the smaller trigons, with the space of the globules; though it is to be observed that there are most pure elements of a similar but purer nature in these very globules, to give their frame-work strength, to temper their activity, and to fix their volatility.

CHAPTER XIII.

The red blood may be called the bodily soul.

Considered in itself the blood is not the soul, but the soul is in it; on which condition alone can the soul govern and determine the ultimate forms which are so far removed from it. Nature is ever acting on her own rules and measured proportions. To act on the parts of the last sphere, she must act through those of the middle sphere, and be with them, and in them. Thus as the blood is the soul's vicegerent in the ultimates of the kingdom, so it may be termed the bodily soul, and subsidiary lieutenant force; particularly in those subjects that allow themselves to be governed by the body, and not by the spirit; such for example as brute animals, and their likenesses in human society. In these, instead of the soul governing the body, the blood and the body have dominion over the soul.

CHAPTER XIV.

There is a common and obscure life in the red blood.

The soul is the only vital essence, or the only essence in which life abides; all other things owe their possession of life to the soul. Such is the case with the blood, in the inmost of which the soul dwells, with life in its train. The blood, however, is but the general or common mansion of the soul, and is not distinctly determined by fibres, and therefore its life is obscure, destitute of sense and all intellectual faculty. Essential determination, or form, is what causes us to live distinctively and individually. Thus from the form we may infer the peculiar life, and hence also the peculiar life of the blood, which becomes a little more distinct in being determined by the arteries and veins; although it never reaches the point which may be called sensual life.

CHAPTER XV.

From the red blood we may judge of the nature of the purer blood; and from the purer blood, the nature of the animal spirit; and from the animal spirit, that of the soul; with the help, however, of the doctrine of forms, order and degrees.

We may judge by the visible and the ultimate of the invisible and the prior, or by the compound of the simple. Compounds can have nothing truly essential in them but the first essence. The nature of the red blood is exposed to sight, but not the nature of the purer blood; still less, of the animal spirit. We may however infer from the former the peculiar essences of the two latter. This way of exploring the invisible and occult parts of nature, constitutes the analytic method; but it is quite requisite to possess the experience of the senses, as well as guiding sciences, or sciences to deliver the laws and order by which nature proceeds, or by which her followers are to proceed. This order appears to dictate, that if there are salino-urinous elements in the red blood, there ought to be similar, but more pure, simple and perfect elements in the white blood, although no eye-sight, however keen, can possibly discover them; and again, that there ought to be similar elements, but most simple and most perfect, in the animal spirit. Otherwise there would be no derivation of one essence from the other, no distinction of one from the other. The degrees of perfection, however, in these and similar entities cannot be explored without a doctrine of forms. In the meantime, from what we have stated it is evident, how greatly the experience of the senses contributes to the discovery of nature's secrets, and that without it we cannot rise to a knowledge of the parts of the higher and simpler spheres.

CHAPTER XVI.

There are three orders of blood, the gross blood, the purer, and the purest.

The red blood is properly termed the blood; but the purer blood not so properly, because it is not red but white; again, the purest blood is the animal spirit. The soul presides over these several fluids; the soul, which is not blood, but the first, inmost, highest, simplest and most perfect essence of the blood, and the life of all. The red blood derives its principal essence from the minuter globules which lie in it, and therefore a volume of such globules cannot fail to be designated blood. The same applies to the animal spirits, which are involved in the purer blood. All these varieties then are denominated bloods, which is also usual in the Holy Scripture. The substantial and essential principle remains the same, while the particulars that vary the notion are mere accidents. If the blood is not denominated from its redness, gravity and crassitude, but from its inner nature, then both the one and the other of these fluids is blood; not so if it be denominated from the before mentioned accidents. In themselves these bloods are indeed most distinct; for they are really and actually distinguished in the body, and yet they exist simultaneously and together in the red humor; hence, for distinction's sake, they require to be signified by different names: and if in no other way, yet always by varying predicates of perfection. Thus we may say that the animal spirit is the first blood, the highest, inmost, simplest, purest, most perfect; that the white or middle blood is prior to and higher than the red, and likewise more inward, simple, pure, and perfect: but that the red blood is the last, lowest, outermost, the compound blood, the relatively gross and imperfect, the ultimate, properly the blood. The same remarks apply to the vessels of the triple blood; for the simple fibres, the compound fibres, and the blood-vessels, mutually succeed and correspond to each other in the same manner and order.

CHAPTER XVII.

The fabric or form of the prior or purer blood is more perfect than the fabric and form of the posterior or grosser blood.

The form of the red blood globule is circular, for the globule is perfectly spherical, and rolls in circles in the vessels; and moreover it includes particles of an angular form. Thus the form of the globules of the red blood is the ultimate and penultimate form. But the form of the globule of the purer blood is not circular or spherical, but spiral; as indeed may be inferred from the circumstance of these globules being oval, and therefore designated* as plano-oval; for the form of a spiral fluxion of parts engenders the external figure or form of an oval. Such is the case also with the cortical glands, which are at once spiral and vortical forms. But the form of the globules of the purest blood is the next higher form, or the vortical. For as the bloods themselves become simpler, so their forms become more perfect. The doctrine of forms, as well as experience, shews that such is the order, and such the ascent of perfections.

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* By Leeuwenhoek.—*(Tr.)*

CHAPTER XVIII.

The three bloods reign both conjointly and separately in the animal body.

They reign conjointly in the red blood, for this has within it both the purer blood and the animal spirit; for which reason we have termed it the repository of the preceding fluids. Conjointly also in the purer blood, which has within it the animal spirit, and the latter, the soul. Each blood also reigns separately; namely, the animal spirit in its own fibres, the purer blood in its own, and the red blood in the vessels. All things in the organic body are thus at once separated and united; and each blood does its own work, and rules its own organism. On these conditions, and no other, can the soul form and govern the body in a just order and succession, and preside over and command it in the sphere of the veriest singulars, and universally at the same time. The more nearly conjoined then these reigning humors are in the red blood, and the more exquisitely discriminated from each other, the more perfect is the organism, and the more obedient all things are to the decisions of the soul. But as soon as ever the distinction and the union are lost and confounded, the sensation and action of the body become comparatively indistinct, indeterminate, unfelt and imperfect. For the above reasons, at every round of the circulation the red blood is resolved into the purer, and this, into the animal spirit; and then the red blood is again composed of the two latter. Thus the circle of life is carried on.

CHAPTER XIX.

The animal spirit acts on the blood, and the blood on the spirit, by means of the vessels and fibres; whence the alternate and reciprocal action of the muscles.

But this proposition need only be stated here. In a subsequent chapter we shall treat of the action of the muscles.

It may be observed, however, that without the discrimination of the humors which are the agents, there could be no reciprocal action, *i.e.* no simultaneous and successive action and reaction.

CHAPTER XX.

The state of the red blood depends upon the state of the purer blood, and the state of the latter upon that of the spirits.

The nature of any compound is according to the nature of that which exists substantially within it; for putting accidents out of sight, the compound derives its nature from that of the simples which it comprehends. The red blood indeed may be defiled with heterogeneous particles; but as the larger portion of it is resolved and recompounded during every round of the circulation, and its hard, or antiquated and indissoluble parts are rejected towards the liver and the gall bladder, so it is purified successively. Therefore so long as the animal spirit and the purer blood remain in their integrity, so long can any morbid state of the red blood, or of the body, be corrected, in which case nature is said to operate the cure. In this way the one flows into and influences the other, and the prior or inner sphere repairs whatever may have fallen into dilapidation in the posterior or the outer.

CHAPTER XXI.

Infinite changes of state happen to both the red and the purer blood.

We shewed in the Treatise on the Spirits, that the animal spirit undergoes infinite changes of state. This mutability of the spirits, this their intrinsic nature, all passes by derivation into the state and nature of the purer blood, and all the mutability and nature of the latter passes again into the state and nature of the red blood; for the state of the one depends by continuous influx upon that of the other. Many peculiar mutations and varieties both in accidents and accessories, are also induced on the purer blood, all and each of which alter the state of the red blood. There are moreover peculiar changes of state in the red blood itself, that is to say, in accidents and accessories. By accidents we mean the situation, position and connexion of the parts which enter and constitute it, consequently the order, which results in the form and quality. The accessories on the other hand are those salino-urinous and sulphurous particles which are taken into the globule to give it coherence and composition. The mutations in the accidents, or in the situation and connexion of the genuine and essential parts, depend in general upon these accessories, and their quality and quantity: hence we have the blood relatively soft, hard, hot, cold, red, pale, or green; in a word, hence the circumstance that the blood is spurious, legitimate, or various. This shews how mutability increases in compounds, and with it, inconstancy and imperfection of various kinds. Each change of state in the simpler parts which lie within the others, induces a change in the compound, though not *vice versâ;* for there are proper or peculiar accidents, as well as accessories, in every composition. That the changes of state in the blood are infinite, or exceed all enumeration, may be shewn analytically and by calculation.

CHAPTER XXII.

The blood of one individual is never absolutely similar to the blood of another.

It was indicated above that the soul and animal spirit of no two individuals are ever absolutely similar or equal in their whole nature and accidents: it follows that the same remark is applicable also to the blood. For the nature of the animal spirit determines that of the purer blood; and this, that of the grosser or red blood. And the latter may be varied in infinite ways besides; for the blood of one subject is softer or harder than that of another; it is heavier or lighter, hotter or colder, paler, redder, or blacker. The globules also differ in size in different persons. Instead of the saline cube or octohedron, the place of the fulcrum may be supplied by a dodecahedron, a hexagon, or a pentagon; which will give rise to a greater or lesser quantity of the purer globules, and to a variation in form. Instead of the urinous salts or subtle and volatile trigons, acids or more fixed salts may be inserted in the angular interstices, or elements of some other description, which will at once alter the state of the globule. The latter may be surrounded with other fragments and floating pieces of the most diverse kinds; and also with chyle and serum equally diverse; not to mention a number of other varieties which it would be tedious to particularize. The existence of these diversities in the different orders of blood, is proved by the common law, that there are as many different bodies, different actions, different dispositions, different minds, inclinations and temperaments, as there are heads and subjects; which induces me to believe, that not only is the blood of one individual not absolutely similar to that of another, but that it is never quite the same in the same subject at any two moments; for the mind, and the animus which depends upon the state of the animal spirits, are perpetually varying; and I further believe, that no two globules of blood are ever absolutely similar. I need not now mention the blood of land animals, birds, or fishes, in which the globules are differently formed, some being oval, surrounded with a thin surface or crust, white, naturally cold, &c., &c.

CHAPTER XXIII.

The red blood is the seminary of all the humors of the body.

"The humors of the body are the following: chyle, milk, blood, serum, lymph, animal spirit, saliva, the mucus of the mouth, bile—the liquor of the pancreas, stomach, intestines, œsophagus, brain, eyes, thorax, pericardium, abdomen, tunica vaginalis testis,—semen, the liquid of the prostate glands, the mucus of the nose, tonsils, joints, urethra, uterus, vagina, and Fallopian tubes,—the humor of the ova, and that in which the fœtus swims, cerumen of the ears, urine, and sweat,"* and a

number of others requiring to be specifically discriminated. It is clear from the very structure of the glands, in which these humors are prepared and elaborated for every use, that the red blood gives birth to nearly all of them. Indeed the glands are composed of nothing but vessels and fibres. The red blood and the purer enter them with their vessels, and the spirit, with its fibres; and then the humor issues forth reconstituted from the glands. This is conspicuously seen in the milk, semen, and saliva. In each of its spherules the blood comprehends mere principles and elements; consequently in potency and virtue it possesses all that is producible in the world by simple principles, elements and substances; in one word, all that is possible. The globule which holds within it these elements and determined unities, and this, so subordinated and coördinated, that it can be readily resolved into them one by one, cannot fail to procreate all species of humors in the universe; and this it actually does, because it is resolved or disintegrated during every round of the circulation. Hence in the nature of things no compound entity can possibly be more perfect than the blood. From this view of the bodily constitution of the blood, it follows that each blood-globule is a kind of microcosm, or contains in act all the series which preceded it, and in potency all which follow it; in potency therefore a whole human race, for the seed arises from the blood.

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* A citation from Heister, *Comp. Anat.*, n. 34.—*(Tr.)*

THE ANIMAL SPIRIT.

THE ANIMAL SPIRIT.

CHAPTER I.

The animal spirit is that most pure humor which flows through the medullary fibres of the brain and the nervous fibres of the body.

This is the general opinion of the learned, as well as our own, and is confirmed by all the phenomena of the case. The existence of the animal spirits is unquestioned, as also that they are conceived in the brain, and sent down through its fibres into the fibres of the body, and ultimately into the motive fibres of the muscles. For without the ministration of the spirits, actions corresponding to the decisions of the soul could never be performed, nor could sensations be conveyed to the soul; and therefore when their descent is impeded, either at the fountain-head, which is the brain, or in the first streams, that is to say, in the medullary fibres, or in the nerves themselves, whether the impediment be the result of compression, division, erosion, or obstruction, the effect instantaneously ceases. Moreover, under the microscope, the fibres are presented as round and hollow cylinders, as if designed to convey a fluid; besides which, without they had a fluid in them, nothing whatever in the animal body would have either origin, progress, order, law, form, or life. The nature, however, of the medullary fibre, and also of the nervous, and the mode in which the latter is connected with the former, will be shewn in the Treatise on the Fibres. Now since it is indubitable that a species of fluid, or a very pure essence, permeates the fibres, the question is, how to name it. In general it is called the animal spirit, and likened to a most pure honor, of such endowment, fluidity and perfection, as to glance through its own invisible fibres, comparatively as the blood runs through the blood-vessels.

CHAPTER II.

The animal spirit is conceived and prepared in the cortical gland, and flows out therefrom into the fibres.

It follows by the very connexion of causes, that the animal spirit cannot be conceived and excluded anywhere but in the cortical gland; which latter is the beginning and head of its own fibre, and the little brain of the same. If then the fibre springs from the gland, and the animal spirit is the spirit of the fibre, the fountain and womb of the spirits must be in the gland. The cortical gland then may deservedly be styled the most perfect model laboratory and chemical organ in the animal kingdom. Moreover according to anatomists this gland contains a little cavity, a simple chamber or ventricle, and has within its structure a pure medullary and cortical substance, whereby it is the most perfect exemplar of the grand brain. There is therefore no doubt that the spirit may be prepared in it. The means, however, and the art, whereby this preparation is effected, and the nature of the spirit produced,—these are the main tasks and difficulties of our exploration. The most learned anatomists, as well as the best authorities on physics, agree with us so far, and therefore ascribe a glandular character and construction to the cortex of the brain. For all the animal humors are elaborated in glands; and the finer and simpler the gland, the purer the humor; which in the highest case should be called not simply a humor, but the better and nobler essence of the humors of the body. Therefore it is designated by the peculiar and appropriate title of the animal spirits.

CHAPTER III.

The quality of the animal spirit may be known from the quality of the fibre that it permeates, and vice versâ.

Such is the correspondence which prevails throughout the animal kingdom, that the nature of one thing may be known from that of another; and this mode of inference is particularly available for the fluids, which permeate the fibres, vessels and ducts. The fibre is formed with a view to its fluid or spirit; the vessels, arterial and venous, are formed with a view to theirs, that is to say, to the blood; and the ducts are formed with a view to the other humors. All these parts from the earliest infancy are inaugurated into this conformity. So mutually are they accommodated to each other, the contained fluid to the containing fibre, or the containing tunic of the fibre, that they make conjointly one cause and one determination. But I forbear this train of argument. Certain it is that the anatomy of the fibre shews the possible character of the spirituous humor; but its internal nature we shall now investigate a little more deeply.

CHAPTER IV.

The animal spirit is the intermediate essence between the soul and the body; hence it is the mediatorial substance which provides for the communication of operations between the two.

This completely coincides with the received opinion of the learned on the essence of the animal spirits. There must be a middle or mediatorial substance to enable the soul to operate on the body. It would be against nature, and contrary to the order of things, if, notwithstanding the provision of a number of intermediate forms, the first form were to pass to and influence the last immediately. The soul is the first, highest, inmost, simplest, and most perfect essence and substance. The body is [illegible], lowest, most external, and most thoroughly compound and imperfect substance. For the first then to operate upon the last, there must be a middle or intermediate that takes its nature from both. In other words, for the most perfect to act upon the imperfect, there must be a link of intercession, to take something from both the perfection of the one and the imperfection of the other. The animal spirit is such a link; and therefore where the animal spirit is wanting, the soul is powerless to govern the body in correspondence to its own operations. This is plain from actual effects and phenomena; the experimental demonstrations on the subject being rather superabundant than deficient. It will, however, be impossible to explain to ordinary comprehension how the animal spirit plays the part of a mediator between the soul and the body, unless we are previously acquainted with the definition of, and the distinction between, the soul and the body. We have already defined the soul, as well as the body. But to enable us to perceive the mediation here alluded to, we ought to know what fluids and fibres they are which determine the form and structure of the body. The first, the principal, and the proper essence and substance of the kingdom, is that which is termed the soul, or the souls'; the last is the red blood. The blood-vessels produce the ultimate form, *i.e.*, the form of the body. The organic structures are called into existence, fashioned and constructed, by mere vessels, and by mere fibres. The animal spirit is therefore the intermediate essence between the soul and the red blood. By this alone can the soul act upon the blood, that is to say, upon the body, which is determined by, and constructed of, fibres and blood-vessels.

CHAPTER V.

The animal spirit partakes of the essence of the soul, and of the essence of the body; that is to say, it is both spiritual and material.

The essence that is intermediate or mediatorial between the soul and the body, must take its nature from both. The soul is spiritual; the body is material. It follows that this animal humor is both spiritual and material. Were it otherwise, the spiritual could never operate upon the material, or *vice versâ*. But how natures so different can be united in one subject, requires to be shewn; although that they are united, is clear from the body, including its viscera, and motory and sensory organs, all of which are animated, notwithstanding they are material.

CHAPTER VI.

*The animal spirit is identical with the purer, middle, and white blood.**

When the red blood globule is divided, disintegrated, or dissolved, other globules are set free, which are not red but white; and indeed according to the often repeated and clear experience of Leeuwenhoek, one globule of red blood gives birth under the above circumstances to six lesser globules of white blood or white humor. Not only have the lesser globules been seen, but their peculiar mode of cohesion, and also of separation, has actually been described, as well as the fact of these lesser globules sundering into others still smaller. To this point at the present day has our vision penetrated, so that we can no longer doubt of the existence of the lesser globules. The volume or humor consisting of them we term the white and middle blood, inasmuch as it arises immediately when the red blood globule is ruptured. This issue of pellucid blood must evidently spring from a source of its own, inasmuch as it is divisible and to the last degree flexible, and therefore cannot but consist of some very pure essence.

The identity between this purer blood and the animal spirit, we deduce from the circumstance of its permeating the minutest capillaries; of its winding its way into the cortical glands, from which it is derived into the fibres, and so accomplishes its circle; from its being of a sufficiently soft nature, perfectly yielding, also divisible, and capable of accommodating itself to every fibre; furthermore from the possibility of its being the intermediate between the soul and the red blood. The latter, that is to say, each globule of it, is in a manner the repository and complex of all the parts or forms antecedent to it in existence, and even derives its principal essence from the soul, being preëminently animate. If then the red blood has its prior essence from this pellucid blood, the latter would seem to have its prior essence from the soul or the primary substance. For it must have in it some deeper ground, something relatively excellent and prior, also higher, more intimate, simple, and perfect. And when phenomena are scanned more nearly, or seen in their causes, they confirm the same position with one accord.

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* [Note by the Author.] This requires alteration, for the spirit is distinct from the purer blood.

CHAPTER VII.

As the animal spirit is conceived and prepared in the cortical glands, it follows that the spiritual and material principles meet in it.

To the end that the marriage of the soul and the body may have issue, and that the progeny may inherit the nature of both the parents, the latter must of necessity meet and combine in that chemical organ where the spirit is prepared. The organic form of the cortical gland, as specified above, contains a minute chamber or ventricle; also a medullary substance of the purest kind; and this, two-fold, or vascular and fibrous; and moreover a simple cortical substance, which is the origin and beginning of simple fibres. By comparing the cortical gland in these particulars with the brain, which itself is a gland and a great chemical laboratory, we may to a certain extent illustrate the generation of the animal spirits; or at all events so far establish it, that when the causes of the phenomena coincide, the above points will go a long way to persuade us.

CHAPTER VIII.

The simple fibre arising from its own simple cortex, pours into the minute cavity or chamber of the gland, a substance of the purest kind, which is conceived and born in the simple cortex, i. e., *the substance of the soul. And the finest vessels, which constitute the other portion of this simple or vascular medulla, supply a lymph or serum of the purest nature, capable of containing the purer corpuscules, or the first sulphureo-saline elements. From the marriage of these two substances the animal spirit is born.*

To understand these positions, it will be necessary to make ourselves familiar with the construction of the cortical gland. We have given a description of it above, where we have shewn, that the simple substance termed the soul, is conceived and born by a transcendent process in the simple cortex; and that the simple fibres are its channels of determination, or the rays of its intellectual light. If then this first substance is conceived in the simple cortex, it must be carried along its fibres whereever the latter are determined. Now that a very large part of the simple fibres terminates in the extremely minute cavity of the gland, is rendered highly probably by the analogy of the brain itself. Thus the medullary fibres of the brain, which commence their course from the cortical glands, end for the most part in the lateral ventricles,* where they exhale and de-

number of others requiring to be specifically discriminated. It is clear from the very structure of the glands, in which these humors are prepared and elaborated for every use, that the red blood gives birth to nearly all of them. Indeed the glands are composed of nothing but vessels and fibres. The red blood and the purer enter them with their vessels, and the spirit, with its fibres; and then the humor issues forth reconstituted from the glands. This is conspicuously seen in the milk, semen, and saliva. In each of its spherules the blood comprehends mere principles and elements; consequently in potency and virtue it possesses all that is producible in the world by simple principles, elements and substances; in one word, all that is possible. The globule which holds within it these elements and determined unities, and this, so subordinated and coördinated, that it can be readily resolved into them one by one, cannot fail to procreate all species of humors in the universe; and this it actually does, because it is resolved or disintegrated during every round of the circulation. Hence in the nature of things no compound entity can possibly be more perfect than the blood. From this view of the bodily constitution of the blood, it follows that each blood-globule is a kind of microcosm, or contains in act all the series which preceded it, and in potency all which follow it; in potency therefore a whole human race, for the seed arises from the blood.

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* This position of Swedenborg appears to be borne out by modern research, although his deduction has not yet been drawn by others. It is now generally admitted that each nervous fibre, including also the medullary fibres of the brain, proceeds singly, *i. e.*, without real anastomosis, from its origin to its termination. But if we regard the whole brain as a cylinder, and compare its calibre with that of all the nerves which issue from it, and of the spinal marrow, the proportion will probably be as more than 100 to 1. A vast body of fibres must then terminate in the brain itself; and where therein but in the ventricles, the walls, sides, or ends of which consist for the most part of medullary substance? This consideration throws important experimental light on the existence of the animal spirit, as well as indeed upon the functions of the brain generally.—(*Tr.*)

THE ANIMAL SPIRIT.

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CHAPTER I.

The animal spirit is that most pure humor which flows through the medullary fibres of the brain and the nervous fibres of the body.

This is the general opinion of the learned, as well as our own, and is confirmed by all the phenomena of the case. The existence of the animal spirits is unquestioned, as also that they are conceived in the brain, and sent down through its fibres into the fibres of the body, and ultimately into the motive fibres of the muscles. For without the ministration of the spirits, actions corresponding to the decisions of the soul could never be performed, nor could sensations be conveyed to the soul; and therefore when their descent is impeded, either at the fountain-head, which is the brain, or in the first streams, that is to say, in the medullary fibres, or in the nerves themselves, whether the impediment be the result of compression, division, erosion, or obstruction, the effect instantaneously ceases. Moreover, under the microscope, the fibres are presented as round and hollow cylinders, as if designed to convey a fluid; besides which, without they had a fluid in them, nothing whatever in the animal body would have either origin, progress, order, law, form, or life. The nature, however, of the medullary fibre, and also of the nervous, and the mode in which the latter is connected with the former, will be shewn in the Treatise on the Fibres. Now since it is indubitable that a species of fluid, or a very pure essence, permeates the fibres, the question is, how to name it. In general it is called the animal spirit, and likened to a most pure honor, of such endowment, fluidity and perfection, as to glance through its own invisible fibres, comparatively as the blood runs through the blood-vessels.

CHAPTER II.

The animal spirit is conceived and prepared in the cortical gland, and flows out therefrom into the fibres.

It follows by the very connexion of causes, that the animal spirit cannot be conceived and excluded anywhere but in the cortical gland; which latter is the beginning and head of its own fibre, and the little brain of the same. If then the fibre springs from the gland, and the animal spirit is the spirit of the fibre, the fountain and womb of the spirits must be in the gland. The cortical gland then may deservedly be styled the most perfect model laboratory and chemical organ in the animal kingdom. Moreover according to anatomists this gland contains a little cavity, a simple chamber or ventricle, and has within its structure a pure medullary and cortical substance, whereby it is the most perfect exemplar of the grand brain. There is therefore no doubt that the spirit may be prepared in it. The means, however, and the art, whereby this preparation is effected, and the nature of the spirit produced,—these are the main tasks and difficulties of our exploration. The most learned anatomists, as well as the best authorities on physics, agree with us so far, and therefore ascribe a glandular character and construction to the cortex of the brain. For all the animal humors are elaborated in glands; and the finer and simpler the gland, the purer the humor; which in the highest case should be called not simply a humor, but the better and nobler essence of the humors of the body. Therefore it is designated by the peculiar and appropriate title of the animal spirits.

CHAPTER III.

The quality of the animal spirit may be known from the quality of the fibre that it permeates, and vice versâ.

Such is the correspondence which prevails throughout the animal kingdom, that the nature of one thing may be known from that of another; and this mode of inference is particularly available for the fluids, which permeate the fibres, vessels and ducts. The fibre is formed with a view to its fluid or spirit; the vessels, arterial and venous, are formed with a view to theirs, that is to say, to the blood; and the ducts are formed with a view to the other humors. All these parts from the earliest infancy are inaugurated into this conformity. So mutually are they accommodated to each other, the contained fluid to the containing fibre, or the containing tunic of the fibre, that they make conjointly one cause and one determination. But I forbear this train of argument. Certain it is that the anatomy of the fibre shews the possible character of the spirituous humor; but its internal nature we shall now investigate a little more deeply.

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The identity between this purer blood and the animal spirit, we deduce from the circumstance of its permeating the minutest capillaries; of its winding its way into the cortical glands, from which it is derived into the fibres, and so accomplishes its circle; from its being of a sufficiently soft nature, perfectly yielding, also divisible, and capable of accommodating itself to every fibre; furthermore from the possibility of its being the intermediate between the soul and the red blood. The latter, that is to say, each globule of it, is in a manner the repository and complex of all the parts or forms antecedent to it in existence, and even derives its principal essence from the soul, being preëminently animate. If then the red blood has its prior essence from this pellucid blood, the latter would seem to have its prior essence from the soul or the primary substance. For it must have in it some deeper ground, something relatively excellent and prior, also higher, more intimate, simple, and perfect. And when phenomena are scanned more nearly, or seen in their causes, they confirm the same position with one accord.

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The simple fibre arising from its own simple cortex, pours into the minute cavity or chamber of the gland, a substance of the purest kind, which is conceived and born in the simple cortex, i. e., *the substance of the soul. And the finest vessels, which constitute the other portion of this simple or vascular medulla, supply a lymph or serum of the purest nature, capable of containing the purer corpuscules, or the first sulphureo-saline elements. From the marriage of these two substances the animal spirit is born.*

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number of others requiring to be specifically discriminated. It is clear from the very structure of the glands, in which these humors are prepared and elaborated for every use, that the red blood gives birth to nearly all of them. Indeed the glands are composed of nothing but vessels and fibres. The red blood and the purer enter them with their vessels, and the spirit, with its fibres; and then the humor issues forth reconstituted from the glands. This is conspicuously seen in the milk, semen, and saliva. In each of its spherules the blood comprehends mere principles and elements; consequently in potency and virtue it possesses all that is producible in the world by simple principles, elements and substances; in one word, all that is possible. The globule which holds within it these elements and determined unities, and this, so subordinated and coördinated, that it can be readily resolved into them one by one, cannot fail to procreate all species of humors in the universe; and this it actually does, because it is resolved or disintegrated during every round of the circulation. Hence in the nature of things no compound entity can possibly be more perfect than the blood. From this view of the bodily constitution of the blood, it follows that each blood-globule is a kind of microcosm, or contains in act all the series which preceded it, and in potency all which follow it; in potency therefore a whole human race, for the seed arises from the blood.

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The threads dividing and ramifying through the gland, constitute the second or vascular substance of its medullary portion.

With regard to the origin of the vascular stamina, these, inasmuch as they pass into the gland, cannot arise immediately from its simple fibres, but must accompany the carotid arteries from the kingdom of the body: for the innermost tunic of the arteries, their membranous and fibrous tunic, is what ultimately remains, and enters the cortical gland. This innermost tunic of the arteries arises from what we term the corporeal fibres. For the truth is that all over the circumference of the body, underneath the cuticle, there are planted an infinity of glands with little mouths and efferent ducts, which exhale the subtlest effluvia of the body, and also imbibe similar but fresh effluvia from the bosom of the atmospheres and of the ether. Similar glandular congeries are also found in the stomach, lungs, and other parts of the system. From these subcutaneous or miliary glands, as well as others, proceed fine ducts, as it were corporeal fibres,* or fibres aspiring to the character of vessels, which weave the innermost coat of the arteries, and at last terminate in the cortical glands, the vascular substance of which they generate. That such is the production of the stamina which enter the cortical gland, is proved by the Sanctorian perspiration; by various morbid, pestilential and poisonous contagions; by the soothing and enlivening effects of spring breezes and exhalations; by the long continuance of life without either food or drink which is usual with certain animals especially; by the infinite pulmonary pipes of insects, which pervade all points of their viscera, nerves, and vessels, even to the innermost parts of the brain and spinal marrow; by the wonderful communication of the glands with the atmospheres, as noticed by Hippocrates; also by the ocean of effluvia surrounding us in the air and the ether. It may be inferred from the origin of these fibres or vascular stamina, that they carry no other than the elemental or material fluid, which in fact they imbibe from the atmospheres and the purest aliments. This then, married to the purest essence in the minute pore or cavity of the cortical gland, produces the animal spirit here treated of.

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* In the language of Swedenborg, the fibres proper belong to the brain, the vessels, to the body; but the fibres which arise in the skin, as the ultimate produce of the brain in the body, are termed corporeal or bodily fibres, and said to be *vasculorum æmulæ*.—(*Tr.*)

And here we might shew by an infinity of experimental proofs, that these vessels imbibe a most pure serum of the nature above described, and transmit it towards the cortex; and that this serum is impregnated with sulphureo-saline principles and elements; also that these elements are so formed, as to fit and adapt themselves to that pure essence; we might, we repeat, shew these points if this were the place to treat of the forms of these parts. The subject however is one that demands a separate treatise, which indeed we have bestowed upon it, but we must not venture to exhibit it here, as it would cause too long a digression.

CHAPTER IX.

There is also a perpetual circulation of the animal spirits from the cortical glands, through the medullary fibres of the brain and the nervous fibres of the body, into the blood vessels, and from the blood vessels or arteries back into the cortical glands, and so again into the fibres.

Besides the living source and spring of the animal spirits, there is also their perpetual circulation, which the most instructed of the learned have not only suspected to exist, but even appear to think they have rendered visible by their microscopes. The arterial vessel runs up to the cortical gland on the one hand, the medullary fibre issues from it on the other: in the gland itself there is a cavity, which like the chamber of a heart draws in the advancing blood, and sends it out into the fibre as its own little artery. Thus there is a perpetual circulation from the arterial vessels through the middle of the glands into the fibres. It is further observed, that the red blood never approaches the gland too near, so as to run into it, but only the white blood does this, that is to say, the red blood after it has undergone resolution, in which case it becomes identical with the animal spirit. The animation or alternate expansion and constriction of the glands, is the means whereby this blood is attracted and expelled. Were it not for this circulation, the system of the fibres would never be accurately filled with the due supply of spirits, an immense abundance of which is momentarily required to enable the sensory and motory organs, and the several viscera, to perform their offices agreeably to the commands of the soul. The animal functions one and all cease in an instant, the machinery labors, and death usurps it, as soon as ever this circulation is arrested, either in the vessels, in the fibres, or in the glands. The purer blood which makes this circuit, brings also similar elements for recruiting the animal spirit.

CHAPTER X.

The soul apart from the animal spirit could never have constructed the simpler and middle organic forms of the body.

By the middle and simpler organic forms of the body, we mean those that the medullary fibre of the brain and the nervous fibre of the body are the only elements to enter and construct. Such for instance are the primitive cerebrum and cerebellum, the medulla oblongata and spinal marrow including all their delicate members and parts, the initiaments of the viscera, and also of the heart and the motory and sensory organs; in a word, all parts whatever to which the compound fibre runs. The whole of these in the primordial stages of formation, are engendered of the fibres alone, and not of the blood-vessels; according to the observations of Malpighi and others. The simple fibre apart from the compound which it forms by circumvolution, gives birth to no organic products; as neither does the soul, apart from the animal spirit, produce any issue excepting the simple cortex, which is the first of organic forms, and the nearest to the soul. Everything then that is organic, partakes of the simple and of the compound fibre, or of the spiritual and the material.

CHAPTER XI.

The soul apart from the animal spirit could never produce the heart; or the vessels, either arterial, or venous; or the red blood; or consequently the ultimate organic form of the body.

According to the theorems of our Treatise on the Fibre, it follows, that there is nothing substantial in the body but the soul and its fibre; *i.e.*, the simple fibre. The reason of this is, that the simple fibres by their determination form the medullary and nervous fibre; this in its turn, the blood-vessels, and these again in conjunction with the fibres form the glands, from which proceed ducts and emissary canals, as it were new fibres or new vessels. Of these then, namely, the fibres, vessels and ducts, the whole system of the body is constructed. Thus the blood-vessels cannot exist without the compound fibres, nor can the latter play the part of fibres without the animal spirit. So when the soul is about to inform or create its body, it has first to produce an intermediate spirit. Moreover the red blood itself has no existence without the same spirit, for this spirit is its principal essence. Accordingly when the red blood-globule is dissolved, it is resolved, according to our proposition, into the purer, middle or white blood, in a word, into the animal spirit.

CHAPTER XII.

Without the animal spirit the soul could determine nothing into action, and could do nothing in the body.

The action of the body depends on the nervous fibres and blood-vessels, which jointly construct the motive fibres. Both fibre and blood-vessel, that is to say, both the animal spirit and the red blood, enter into every muscle; according to the plain shewing of experience. The spirit and the blood are clearly the efficient causes of muscular action; this is proved by convulsions, tetanus, spasms, by paralytic, apoplectic, and epileptic cases; also by the circumstance that the action of the muscles is lost at once when the fibre or blood-vessel is divided, compressed, or obstructed. Therefore in order that action may proceed from the will, and the will which regards such action, from the choice of the mind, both the spirit and the blood are absolutely necessary. The spirit is the middle substance which is under the command of the soul, while the blood is the ultimate substance, whose duty it is to obey. The anatomy of the brain however teaches the manner in which the soul determines its will into action; shewing in fact that this takes place by the constriction and expansion of the cortical glands, whereby the animal spirit is expressed into the fibres, and at length into the motive fibres of the body, just as the blood is expressed from the heart into the arteries; and constantly the blood reacts, and recovers its state; and in this way action becomes reciprocal.

CHAPTER XIII.

Without the animal spirit, the soul could feel none of the changes that happen to the body.

All the organs of the senses are provided with particular nerves. The eye is furnished with the optic nerves; the ear with the auditory nerves of the seventh pair; the tongue, with the gustatory nerves of the fifth and ninth pairs; the nares with the olfactory nerves, which lie like teats on the front of the cerebrum. When these nerves are either divided, compressed, obstructed, or their action otherwise weakened, the particular sense to which they minister is instantly deprived of its sharpness in exact proportion to the extent of the violence or lesion. This is a piece of simple experience. The nerves, however, consist of medullary fibres, that is to say, of the fibres that arise from the cortical glands; consequently there can be no actual sensation without the fluid and spirit of those fibres. And indeed sensations cannot ascend immediately to the soul; they cannot rise thither without an internuncio like the animal spirit.

CHAPTER XIV.

The nature of the action and sensation, and even of the imagination and thought in an individual, are correspondent to the nature of the animal spirit and the circulation thereof in the body.

This is a consequence of the preceding theorems. If the soul cannot act in the body, or feel in the organs, without the animal spirit, it follows that the action and the sensation are correspondent and proportional to the animal spirit which produces them both. This is very manifest in drunkards, and in insane, idiotic and other subjects whose animal spirits are either contaminated, or else circulate irregularly, or too small or too large a supply of them is sent to the sensory and motory organs. The very speech, gait, countenance, even the eyes of such persons, clearly proclaim the state of the spirits, and shew that they are excited by various substances and the goads of alcohol; from the cross action of which disorder invades the speech and actions. The subject of the imagination, however, whose ideas are changes of state in the cortical gland, and of thought, the rational ideas whereof are similar changes of state occurring to the simple cortex—these subjects will be considered in the sequel. Meanwhile the nature of the imagination determines that of the sensation and action, which latter descend from imagination as their proximate cause.

CHAPTER XV.

The animal spirit makes us both spiritual and corporeal.

By the definition of the animal spirits, they partake both of the soul and the body. Moreover the nature of the spirit, including its circulation, determines the nature of action, sensation, imagination and thought. By consequence from the nature and quality of these spirits we derive the fact, that we are spiritual, and that we are corporeal or material. The more of the soul there is in the spirits, the more spiritual we are, and *vice versâ*. Hence it appears that those who eat gross and impure food, and sink their minds in the earthy sphere, have an impure animal spirit, impregnated with material forms; which indeed experience shews to be the case.

CHAPTER XVI.

In the human microcosm, all that is above the animal spirit constitutes the inner man; and all that is below it, the outer.

The soul is above the animal spirit; the red blood and the still grosser humors are beneath. The soul is spiritual, and the soul's operation, whereby it regards the body, is celestial.* The blood on the other hand, as it abounds in saline elements, is for the most part corporeal. Both these natures, however, are contained in the spirit, which is equally near to both. The higher essence is also simpler, prior, more perfect, and at the same time more internal; the lower is relatively compound, posterior, imperfect, and external. Therefore the inner man is above the animal spirit, and more perfect than it; and the outer man is below it, or more imperfect. But the mode whereby the internal or spiritual operates upon the external or corporeal, will be explained in our Treatise on the Intercourse between the Soul and the Body.

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* It is to be observed, that Swedenborg does not here use the terms *spiritual* and *celestial* in the sense in which they occur in his Theological Works; but with the signification which they bear in his *Animal Kingdom*, Vol. I., p. 126, where the perpetual vortical form is designated *celestial*, and the perpetual celestial, *spiritual*; the latter being therefore above the former.—*(Tr.)*

CHAPTER XVII.

The animal spirit is never absolutely similar in any two individuals; on the contrary it is different in all the subjects of human society, and always different at different times in one and the same person.

Throughout the whole of human society the state of no two souls is ever absolutely similar; and the same remark applies to the red blood as to the soul. It follows that the animal spirit can never be absolutely similar in any two cases. For the animal spirit is the middle or mediatorial essence, whereinto the soul flows from above, and the blood from below; as already mentioned. Moreover the animus depends on the nature of the spirits; wherefore there are as many varieties of the one as of the other. The truth of this is established by experience. We never meet with the same face, or the same speech, actions, or any other conditions, in any two persons, but the grounds of distinction are infinite. And as these forms cannot be engendered without the ministration of the spirits, and as in their production and construction they follow the quality, quantity and circulation of the latter, so it is evident that the spirit can never be absolutely equal or alike in any two instances. Consider also that the perfection of nature, the nature of nature, consists in the fact, that one thing is never identical with another in the whole range of its essentials and accidents. As for quality, the spirits are impregnated with vast numbers of sulphureo-saline elements, and which are more abundant in some subjects than others; also with diverse other species of elements that they imbibe from the bosom of the atmosphere and from the inner parts of the food. Thus the causes of variety in this respect are infinite. The cortical gland also, which is the organ for the preparation of the spirits, differs in different subjects; prepares the spirit differently in different subjects; admitting thereinto, and mingling in the composition, a greater share of one nature in one case; a less in another. The quantity also is various in every instance, as the spirit is elaborated and expended according to the requirements, uses, and necessities of the body. It differs in fact in every case. Likewise the circulation of the spirits, which depends altogether upon natural necessity and rational use. For the cortical gland expands and contracts continually and variously; consequently such a quantity of spirit is attracted from the vessels and expelled through the fibres, as the body including the sensory and motory organs requires. Thus the state of the circulation varies every moment in every man. And this is completely confirmed by the affections and ailments of the animus, and by the diseases of the body.

N.B. The purer blood is a different thing from the animal spirit. The former is the fluid that arises out of the resolution or disintegration of the red blood; but the latter consists of the spirits, with volatile particles, comprising the first saline and sulphureous elements, inserted between them.

SENSATION OR THE PASSION OF THE BODY.

SENSATION OR THE PASSION OF THE BODY.

CHAPTER I.

Sensations are external and internal.

The external or bodily senses are those of touch, taste, smell, hearing, and sight. Internal sensation consists in the perception or apperception of the objects that flow in from the organs of the external senses. Intimate sensation is identical with intellection or understanding, for the objects that are felt and perceived are also to be rationally understood. The innermost of all, or the principle of sensations, is the sense of the soul, and is identical with pure intellection or intelligence; for the endowments of sensation, perception, and intelligence, are due to the soul alone. As sensations are external and internal, so are their organs also. The organ of touch is coextensive with the circumference of the body. The tongue is the organ of taste. The membrane lining the nares and nasal cavities is the organ of smell. The ear is the organ of hearing, and the eye of sight. The cortical cerebrum, or the cortical substance of the cerebrum, is the organ of perception. But the organ of intellection or intimate sensation is that very pure or simple cortex contained in each cortical gland. These organs, the internal as well as the external, constitute sensoria, and of all the external the cerebrum is the common sensorium.

CHAPTER II.

External sensations communicate with internal, or the external sensories with the more internal and with the inmost, by means of the fibres.

The most slender knowledge of anatomy is sufficient to shew, that internal sensations effect their communication with external by means of the fibres. A fibre runs up from every point of the skin towards the spinal marrow, or the medulla oblongata; and this is why these fibres are termed sensorial, to distinguish them from the motory fibres. A fibre of the ninth, eighth, and fifth pairs of cerebral nerves runs from every point of the tongue. A fibre runs from the nares through the cribriform plate to the mammillary processes, which are affixed like bottles to the anterior part of the cerebrum. A fibre both of the portio dura and portio mollis of the seventh pair runs from the ear. The great optic nerve proceeds from the eye. These fibres run on until they reach their principles or sources, namely, the cortical glands. Internal sense resides of a certainty in these principles or glands, and is dependent on their changes of state. Simple fibres again are put forth by this gland to a certain still purer cortex, which we term the simple cortex, and on this hangs our intellection of all objects apperceived and felt. Thus by means of the fibres there is a continual communication between external sensations and internal. For this reason it is, that the senses languish and die away as soon as ever the intermediating nerve is either divided, strained, or obstructed; as we know to be the case from innumerable facts occurring in disease.

CHAPTER III.

No sensation is possible without a convenient organic substance.

There can be no sight without an eye, no hearing without an ear, no taste without a tongue, no smell without a pituitary membrane. And as the external senses can have no existence without a suitable organic substance, in short, without organs, so neither can the internal senses. The cortical gland is the organic substance of perception, and the simple cortex is the organ of intellection; as indicated above. It is absolutely repugnant to nature that a sensitive or intellectual principle should exist at all without a corresponding substance, inasmuch as sensations are but forces and modifications, which proceed from substances in action. Thus the soul is the only sentient and intelligent substance in the body.

CHAPTER IV.

The nature of the sensation is as that of the organic substance; and vice versâ.

The nature of the hearing determines the character of the ear; and the nature of sight that of the eye; and *vice versâ,* the nature of the ear determines the character of the hearing, and of the eye, that of the sight. The same remark applies in other cases. Thus in the inner sphere, the nature of the perception or imagination determines that of the cortical gland, which may be termed the internal eye or eyelet; and again, the nature of the intellection determines that of the simple cortex. And *vice versâ.* Wherefore all sensation corresponds and coincides with the state of its particular sensorium. If sensation belongs to an organ, it must necessarily exist according to the state of that organ.

CHAPTER V.

The nature of the external sensation is determined by the nature of the communication with the internal sensorium.

It is not the organ of external sensation that feels, but only the soul, for the soul understands what the sensation is. Consequently the organ of external sense is but the instrument for receiving the first advances and touch of objects, or the forces reaching the system. Thus it is that when the eye is closed, and the ear reposes, as during sleep, we still seem to see and hear; and that when the power of perceiving is lost in the brain, the external organs are at once deprived of sensation, though not *vice versâ*. This causes our sensations to become either dull, acute, obscure, or distinct. It is evident from the diseases of the head, that sense varies with the state of the brain. Thus the fibre is either relaxed, as in sleep, or tightened and stretched, and raised and rendered distinct for sensation, as in the waking state; or is inflamed and heated, or else affected in some other way. From moment to moment the sense varies, with the state superinduced upon the fibres, or to which the fibres are reduced.

CHAPTER VI.

The form of the sensation is as the form of the organ.

If the organ be the substance, and the sensation the modification, and if no sensation is possible without an organic form, then it follows that the substantial form, namely, of the sensorium, must coincide with the form of the modification or sensation. Form may be predicated both of substance, and of forces and modifications. Form is constituted of essential determinations, which determinations are inconceivable apart from the idea of the coexistence or fluxion of individual things. If the latter are set in action, a form of modification is produced, which cannot fail to be similar to the form of the substances with their determinate fluxion. Therefore sight is as the form of the eye; hearing is as the form of the ear; perception and imagination are as the form of the cortical gland; and so forth. When the organ therefore alters, the sense resulting from it alters conformably. It would however be tedious to enquire into the peculiar form of each organ, and of the sensation resulting from it. The form of the eye and of sight is more perfect than that of the ear and of hearing. The form of the cortical gland, or the internal sight, is more perfect than the form of the eye, or the external sight. Thus the perfection of organic forms grows and rises by degrees all the way to the soul, which is the forms of forms in its own particular body, the informing principle of all its other forms. The more perfect forms are otherwise regarded as superior, prior, more simple, and more internal.

CHAPTER VII.

The internal sensation can exist and live without the external, but not vice versâ.

So long as the brain is uninjured, internal sensation, comprising perception and intellection, or imagination and thought, remains in its vigour, however the organs of the external senses may fail. The deaf and the blind can still reason and think. But as soon as the general sensorium or the brain is attacked, the organs are deprived of the faculty of feeling. The latter therefore depend upon the former, and not *vice versâ*. Hence it follows that:—

CHAPTER VIII.

It is the soul alone which feels, perceives and understands.

The soul is the pure intelligence and life of the body; the proper centre to which all the deeds that are done at the circumference are referred. The organic substances, however, or sensations, are subordinated to it. The first sensation after the soul is rational intellection, intellect or understanding, which is a mixed intelligence. Next under this comes perception; and beneath this again those five sentient powers mentioned above, viz., sight, hearing, taste, smell, and touch; which are the outermost substances or sensations, and proper to the body, although the distance of all from the soul is not alike, but one is nearer to it than another. Thus the soul is only accessible by degrees, and must be approached by a peculiar ladder. If any middle sensation is weakened or destroyed, the approach to the soul is to that extent hindered or cut off; though all the time the soul remains in its own centre and its own intelligence, without having any communication with the body. For example, hearing is not possible apart from a particular internal sight almost like eye-sight; the latter again is impossible apart from the intimate sight which constitutes thought; which in its turn, being a mixed intelligence, is impossible without a pure intelligence: a mixed intelligence necessarily implies the existence of a pure intelligence above it. The consequence is, that there can be no sensation without the soul, which is the only part in the body that feels, as it is the only part that purely understands what is felt.

CHAPTER IX.

All sensation, both external and internal, is a passion; hence during sensation the soul is passive.

Before the eye can see, the object to be apprehended by sight, the representations and appearances, the variously combined colors and modifications of shade and light, must necessarily influence or flow into it. For the ear to hear, necessarily the sound must impinge on the tympanum and fenestæ. For the tongue to taste, sharp-pointed, saline and other particles must be provided, to strike the papillæ of the organ. Similar conditions are required in order for the nares to smell. All sense then takes place by touch; the touch being subtler, and merely involving forces and the forms of forces in the ear and eye, but comparatively heavy and gross in the tongue and nose; and heaviest and grossest of all in the skin and membranes, whose sense constitutes touch proper. There is then no sensation apart from touch, but sensation is produced in adaptation to the whole form of touch and tacitile objects: therefore it is not action but passion. The inner sensation, or first perception, is also a passion, but comparatively perfect and pure; for the internal sensorium perceives nothing but what comes from the external sensoria; and perceives them in such wise as the images and ideas flow in. The same is the case with intellection, which is intimate sensation, and depends upon perception as perception depends upon sensation. By this scale we advance to the soul, which alone feels because it alone understands. Hence the soul is passive during its feeling, or in its sense; and this is why it is delighted with the harmonies of things, and pained by their discords.

CHAPTER X.

The modifications of the air and ether in the world correspond to hearing and sight in the animated body: and these modifications live, and become sensations, the instant they come in contact with a sensorial organ conformable to them.

As are the modifications of the air, such are the modifications, *i.e.*, the tones, sounds or harmonies, of the ear. And as are the modifications of the ether, such are the images of sight. Modifications extraneous to the animate body are inanimate and dead, but as soon as they touch the body, they are transformed into sensations. This is why sensations are commonly called modifications, and organs are said to undergo modification. When modifications approach the very threshold of the body, at the moment they touch or breathe upon it, they partake instantaneously of the life of the soul, which feels what the peculiar modification is, and what it represents. And as every organ must undergo modification before it can feel, so it is passive, not active; that is to say, sensation is a passion and not an action.

CHAPTER XI.

The ideas of the memory are similar modifications to the images of sight, but fixed in the organs, whereby they present themselves to imagination and thought, as external objects present themselves to sight.

The memory is the field of images spread before the internal sense, (which images however are living, and constitute ideas,) as the visible world is the field spread before the external sense of sight. The images of the memory present themselves in this wise to imagination and thought. Therefore the internal sense as well as the external must be admitted to be passive; though passivity is especially predicated when modifications are insinuated immediately through the outermost avenues of the external senses.

CHAPTER XII.

By the instrumentality of sensations the soul desires to know what is going on in the world below it, whither it descends in forming the body, and the sensory and motory organs.

The soul, which is a spiritual and celestial form, can have no share in, and enjoy no consciousness of, those effects and phenomena that take place in a world so far away from it and so much beneath it, unless by the instrumentality of organs which are exactly conformable to the forces of that sphere, and unless there be a scale of organs and sensations, to admit of the descent from above to below, and *vice versâ*. The organic body is framed to meet the case. The scale or ladder has distinct steps or degrees, which make it possible to pass successively from one region to another. By this means nothing whatever can happen without the soul having a share in it. All sensation is raised from the lowest world to the soul as its heaven, and all action passes down to the lowest world from the soul as its heaven. Hence it is not what enters the soul that emperils it, but what comes forth from it; *i. e.*, not sensation, lust, or desire, but actions and effects. By touch the soul feels the presence of whatever in general comes against the body: by taste, it feels whatever is floating in water and other liquids: by smell, whatever is floating in the atmosphere: by hearing, all the modifications of the same atmosphere: by sight, the corresponding modifications of the ether, and all the beauty which the earth brings forth: by the innermost sense it feels whatever is done in the upper world, and in the region of causes and principles. And so forth.

CHAPTER XIII.

The organs of the external senses are constructed with the most elaborate reference to the whole form of forces and corresponding modifications.

The eye is exactly suited and made to the modification of the ether; the ear, to the modification of the air; the tongue, to the forms of angular bodies; so likewise the membrane of the nares. And that the cortical gland is fashioned to the form of the modifications of a higher ether, may be concluded from various phenomena. To mention only one or two specific arguments. The ear is furnished with the tympanum, with the fenestræ, with cylinders, with the cochlea, the malleus, and other machinery, which constitutes it the most perfect exemplar of acoustic art. So the eye in its orbit represents the master-piece of optics, being framed with express relation to all the nature of the influx of the solar rays. The same too may be said of the other sensories, in which nature's inmost secrets lie concealed and represented. The consequence is that the soul, which is the formative substance and force of the body, thoroughly knows, sees and enters into nature itself, and so moulds her instruments that they present not the slightest oppugnancy to the order and form of its fluxion. For the soul is in a manner above nature; and hence is the science, art, order, and law of all lower things in the microcosm; wherefore in acting from science, art, order, law, the soul acts from itself.

CHAPTER XIV.

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THE ORIGIN AND PROPAGATION OF THE SOUL.

THE ORIGIN AND PROPAGATION OF THE SOUL.

CHAPTER I.

The soul of the offspring comes from the soul of the parent.

No one, I imagine, doubts that the first soul, I mean, the soul of the first man, was created by God immediately, and infused into a new body; in fact, that his soul, which perhaps was like a vegetable soul, or was not only spiritual, but natural too, was so purified as to acquire a spiritual essence and nature. The vegetative soul differs from the living souls of the animal kingdom, especially in the circumstance of being not only a spiritual but also a natural form; that is to say, in having the lower forms, as the first, second and third natural, added to it; but when these natural forms are cast off or separated, a pure spiritual form, such as the human, remains. But let us dismiss these speculations. Any one may frame guesses indeed, but let no son of earth pretend to penetrate into the mysteries of creation. Our only intention at present is to treat of the successive origin, or propagation and transmission, of souls from one body to another.

It will be impossible to doubt that the soul of the offspring comes originally from that of the parent, if we consider that the soul is all in all in the whole and in every part of the body, (it is all in all in the simple fibres, and is the principal and ruling essence in both the white and the red blood); that it is an essence so real that it alone is, lives, feels, acts; that the soul is the veriest creative and formative substance of the body, that is to say, the informing substance of all the organic forms, whereof the body is the last. Without the soul or first form no organic forms could possibly be engendered or exist. Whatever is to undergo formation, or derivation, successively, must always begin from a first form. We shall be further confirmed in our view of the origin of the soul, by attending to visible phenomena: to the likeness to both parents which the common offspring exhibits both in mind, disposition and body; a likeness not merely observable in man, but in the brute creation; and even in the subjects of the vegetable kingdom, in so far that like procreates like. In the animal kingdom the image and likeness of the parent are transmitted to the children's children; nay, from Adam to his universal posterity. Moreover there is a general and specific, and even an individual likeness in families, which if it does not pass immediately to the next descendant, only runs onwards another stage, to the grandson or the great-grandson: while in each instance the family likeness is constantly preserved, which distinguishes it from other families. If then the organic body is the type, image and picture of the soul, and if the body originates from the soul or the first form, it follows that the soul of the offspring must be from the soul of the parent. This is again corroborated by the examination of the generative organs in both sexes, from which, if we follow their anatomy, and the visible experience of phenomena, we may clearly deduce the manner in which the first essence of the bloods is disposed for procreation or propagation. The soul, as we indicated above, consists of innumerable simple substances or first forms. Thus the soul of the parent is propagated in the offspring, although the whole of it is not transferred, but only such a share, or if we may be allowed the expression, such a minute portion, as will suffice for initiating the organic or corporeal forms.

CHAPTER II.

The soul of the offspring is conceived in the male, but clothed in successive order with the requisite organic forms of the posterior sphere, in a word, with the body, in the ovum and womb of the mother.

This proposition is plainly enough attested by the generative organs when intimately examined and considered. It is p we say, by the spermatic arteries, veins and nerves; b testicles and seminal vessels, and the epididymides attached to the upper border of the former; by the vesiculæ seminales or cellular receptacles; by the prostate glands at the neck of the bladder; by the urethra, and Cowper's and Littre's glands; by the seed itself, and the living animalcules it contains: moreover, by the corresponding organs in the female, as the uterus, the Fallopian tubes, the ovaries, and the other members; than all which, universal nature offers no more wonderful spectacle to human eyes. But the offices of the several organs of this series, can only be explained in our special Treatise on Generation. I may however state, that on opening them up into their causes, I seem to have discovered a connexion and progression in those causes which prove that the first rudiments of the brain are conceived in the organs of the male; and by the first rudiments, I mean the purer cortex contained afterwards in the cortical gland; and that the organic forms are projected from this as the initiament of the body, and afterwards, so commenced, advance successively in the ovum and womb of the mother, thereby producing the body. This successive order is also proved by the growth of the little members of the chick in the egg. If the posterior forms are to be engendered by their first form, this must be accomplished successively. Nothing that involves coexistence can exist all at once or simultaneously. Did it so exist, the last organic forms could never arise from those next above them, nor these again from the first form. In short, the body could never exist from its brain, or the brain from its cortical glands, or these from their simple cortex, or this from its soul, which is the first, highest, inmost, simplest, and most perfect form. Without the cortex not a fibre is produced, and without the fibre no organic form.

CHAPTER III.

The simple animal substances or primary forms are conceived and excluded by a transcendent process in the simple cortex, and so the soul is procreated in every living creature.

The simple cortex, or that which is the intimate ag the cortical glands of the brain, is the first of the soul's organic forms, and its operation is intellectual or rational, being that of human thought. In this simple cortex and nowhere else can the first animal essence be conceived and procreated. Thought or the operation of this cortex is even spiritual in its nature, and actually undergoes infinite changes of state, containing as in a centre, and contemplating in a single simple idea, all things that there are in the body. As soon therefore as ever this form is conceived, it is conveyed into the simple fibres, and by them to the universal body; for the simple fibres dart from this cortex as rays of the soul's intellectual light. But this conception and generation are effected in a transcendent way. As the brain is the organ for the preparation of the red blood, so the cortical gland is the organ for the preparation of the purer blood or animal spirits; consequently the simple cortex is the organ for preparing the first essence of the blood or the first living essence. These cerebra and cerebellula mutually correspond to each other in succession. But as this generation is not effected by the cortex, but in the simple cortex, and this, by a transcendent process, so it will require to be investigated from the laws of order and by the doctrine of forms. Therefore the subject does not admit of a short statement.

CHAPTER IV.

The body and the animal kingdom are at an end as soon as ever this living spring and perennial source of the soul are arrested.

If in the whole body there be nothing substantial and alive but the soul, and if the soul be the one only substance that reigns universally in all singulars, and most singularly in its universe; and if it be the source from which all the organic forms are derived, including at last the ultimate form or the body: if moreover it be the principal and intimate essence of the animal spirits and the red blood, and so prolific as to afford initiaments for the propagation of new forms,—if all these predications of the soul be true, it will follow that it must arise unceasingly, in adaptation to all the uses and necessities of the kingdom, and spring from the above source. This is clearly proved by failures of the spirits originating from a vast diversity of causes, and followed by ailing conditions of the animal mind, by dimness of sight, lipothymia, syncope, deliquium, paralysis, stupor, sleep, loss of memory, languor of imagination, dullness of thought, indeterminateness of will, loss of desire, extinction of vital heat, premature old age, and an infinity of other effects.

ACTION.

ACTION.

CHAPTER I.

The action of the whole body, its viscera, and their parts, is performed by the motive fibres and the muscles.

The early stages and successive growth of animal embryos, afford clear proofs that muscle and muscular action are ultimate determinations. The simple fibre which comes first of all, immediately that it springs from its natal cortex, forms or builds the medullary or nervous fibre by a process of convolution, and the latter again engenders the blood-vessel. This is in order that the nervous fibre and the blood-vessel may construct the motive fibre of which the muscle is composed. Thus the motive fibre, by means of which action is produced, is the last or ultimate determination. There is however the simpler motive fibre and the compound. The simpler is composed of nothing but nervous fibres and capillaries, the latter containing the purer blood. The compound is made up at one and the same time, of nervous fibres, capillary vessels, and of the vessels which carry the red blood. Both a nerve and an artery go to every muscle. Meanwhile, the universal body, the viscera of the body, and the parts of the viscera, are constructed of nothing but motive fibres; the reason of which is, that all things therein are born and made for some action, that the soul may be represented in a type by real actions in the extreme sphere; for the soul would never be justly manifested in the ultimate world, unless it became active by the muscles.

CHAPTER II.

The body is so articulated by the muscles, that there is no part without its peculiar motion and action.

The first inspection and contemplation of the animate body when stripped of its integuments, is sufficient to shew, that the whole frame is so distinct and articulate with muscles, as to represent all possible actions whatever that are conformable to the operations of the soul. The heart is in all respects a muscle, and so articulate, that it admits of being expanded, compressed, flexed and reflexed in a thousand ways; and its auricles the same. Likewise the lungs, the stomach, the intestines, the liver, the diaphragm, &c. Which shews that everything belonging to the body, everything corporeal, is also muscular, or what amounts to the same thing, is ready for motion and action. There is not a single artery but is begirt by muscular circles, to accommodate itself to the blood and the fluxion thereof. The same may be said of every fibril in every circle. This is very plain in the fibres, which are the minutest parts of the body. Every one of them enjoys its own peculiar activity, though on such conditions, that it is bound down to act for the community it belongs to at the same time as for itself. Such also is the condition of the parts of the whole body and all its viscera. Therefore whatever part therein is not active, cannot of right be regarded as living or animate; since it is the end of formation in every part, that such part should operate answerably to the force of the soul.

CHAPTER III.

Each individual part of the animated body has its own proper motion, and each action consists of an infinity of motions as its parts.*

That each, even the very least, individual part has its own peculiar activity, is a point which receives an especial attestation from the growth of the embryo in the womb, and of the chick in the egg. Each several fibre is so separated from its companion, at the same time that it is linked to it, and bound down to serve it, that it at once attends to its own interest and subserves the common weal. In the periods however of advancing life and old age, the fibres either grow together, or they are parted asunder, and confused and indistinct action is the result. Indeed when one part acts either separately from, or altogether unitedly with, another, there can be no liberty, and where there is not liberty there cannot be harmony. In proportion then as the viscera, and the parts of the viscera, are distinct and free, at the same time that they are unanimous and actually united in guarding the common weal, in the same proportion their state is perfect. These are in fact the only conditions on which the body can comply with the bidding of the mind, which operates in the highest sphere of singulars. This is corroborated by experience, for the obedience and soundness of the body are lost as soon as ever the parts either grow together, or separate from each other.

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* The translator has preferred to retain in general the term *animated* rather than to use the more English word *living*; because the former appears better to express

CHAPTER IV.

The character of the action is determined by the nature of the muscle.

If muscle be the instrument or organ of action, then it follows that the form of the action must depend upon the position, connexion and quality of the muscular fibres. A muscle consists of a fleshy belly and a tendon, which may be divided into other lesser parts exactly similar to the larger. The tendon too is partible into the same number of fibrils as the muscle. Furthermore the muscles are enveloped in several membranes of a thin and cellular nature. Both an artery and a nerve enter every muscle; and when the muscle undergoes motion and re-

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that master idea of Swedenborg, that man is not a life, but an organism recipient of the One Life; and that the doctrine of pure life must be referred to theology, not to physiology or psychology, or any branch of philosophy; moreover that we look in vain in ourselves for a self-intelligent soul. See the Index to the *Economy of the Animal Kingdom*, article SOUL.—*(Tr.)*

laxation, the blood is reciprocally expressed from it, and attracted to it, with great force. The form of the muscle, and the form of the action, depend conspicuously on all these circumstances. The precise nature however of the several moving fibres has not yet been investigated. But meanwhile that the action is altogether dependent on the state of the muscle, is clearly shewn in paralysis, tetanus, spasms, and convulsions; and by the division, relaxation, tearing and obstruction of the fibre or the artery supplying the muscle. Therefore the form of the action is as the form of the muscle.

CHAPTER V.

The body lives in acting, and acts in living.

The body is said to die when it ceases to act; and the more perfectly it acts, the more perfectly it lives; therefore when a member is deprived of its action, it may be regarded as extinct. The body including its members is the ultimate form of the soul. The members are not alive, unless they live, that is, act, at the bidding of their mind. They are but ultimate determinations, which do nothing of themselves, but act from a higher power, which determines them, and has life in it. Hence action is the life of the muscles. This is the reason why death seizes the members, the limbs, and the muscles, in the first instance, and advances by degrees to the inner parts. For we cease to act before we cease to will to act, that is, to live.

CHAPTER VI.

Without the animal spirit, and without the blood, or without the fibre and the artery, no muscular action can exist.

This is clear from experience, since both a nerve and an artery enter every muscle. The nerve with its fibre vanishes altogether away in the muscle; while the artery divides and ramifies through its body in such a manner, that the muscle appears entirely arterial and sanguineous; besides which the artery has a corresponding vein. Hence it appears that muscle is constructed entirely of arteries and veins; or contains no prevailing element besides the artery and vein, or in other words, besides the blood and the animal spirit. When therefore the artery or nerve are injured, divided, compressed, or relaxed, the action of the subject muscle is lost at once in proportion to the degree of the mischief. But our theoretical examination of the fibres and vessels, or of the animal spirits and the blood, shews us also how these two elements respectively flow in. The blood-vessel is in fact composed of nothing but fibres. When therefore the fibre acts, the artery is constricted, and the blood expelled; and when the fibre does not act, the blood rushes in, and recovers the artery. Hence the reciprocal action, or the action and reaction of the muscles. The blood is passive, and reagent against the spirit, which is active. The tissue of the motive fibre, however, cannot be made clear to the evidence of reason without a previous citation of experimental data.

CHAPTER VII.

There are three general sources of motion and action in the animal body; namely, the animation of the brain, the systole and diastole of the heart, and the respiration of the lungs; besides which there are many specific sources, and innumerable particular ones.

The actions of the animal body constitute an entire series, order, and form. They may be classed under superior universal, and inferior universal, or as general, specific, and individual. One is under another, and one is in another, just as is the case with substances; for action proceeds from substances as its instrumental causes. The animation of the cerebrum, cerebellum, medulla oblongata and spinal marrow, is the most universal source of motion and action in the body, and the whole nervous system, that is, the organic body, is inspired and vivified with its active spirit by this animation. The systole and diastole of the heart are a less universal source, since the motive fibres of the heart as well as of the arteries and veins are dependent upon the inspiration of the nervous fibres. The respiration of the lungs is a source still lower in point of universality, and conspires both with the animation of the brains, and with the systole and diastole of the heart. The other motions of the body, or as we term them the special motions, may be likened to streams flowing from the above three sources or fountains. They comprise the motions of the several viscera and members. Every member has its own proper motion and proper action; and this is true whether we apply it to the stomach and the intestines, or to the liver, pancreas, and spleen, or to the arms, loins, feet, fingers, or toes; in short, as we said before, it is the case with all the members in the body. There are also particular motions in every viscus, motions for instance of the glands, vesicles and delicate muscles of which the entire member or viscus is composed. These motions again involve motions more particular still, as of the motive fibres in every ~~the~~ smallest muscle, and in every gland; of the arterial and venous vessels in these, of the nervous fibres in these, and of the simple fibres in these; and so forth. The bodily system is perfect in proportion as the singular activities are perfectly distinct, and yet conspire in finer harmony with the universal.

CHAPTER VIII.

Speech is the action of the tongue, larynx, trachea and lungs.

In the enunciation of the articulate sounds of the voice, the tongue, which is in all respects muscular, has to be folded in different ways, and the fauces also applied, while the chamber of the larynx is moulded after the nature of sound, and likewise the trachea. The lungs also which supply the air, are required to accommodate themselves to all the other parts. Thus innumerable motive fibres necessarily conspire to the articulation of a single sound. But the action of the tongue differs from that of the other members in no respects but velocity and volubility. The motions of one member may be extremely rapid, those of another slow and sluggish. This is shewn in birds and insects, whose wings vibrate with such rapidity, that the alternating activity simulates continuous repose, and comes to the ear as a murmuring sound. The speech of the tongue comes from the same source as the other actions of the body.

CHAPTER IX.

The cortical glands in the cerebrum and cerebellum correspond to the motive fibres in the muscles of the body; consequently the action of the cortical glands corresponds to the action of the muscles.

The nervous fibre exists from the cortical gland, which latter therefore determines it. On the other hand the motive fibre of the muscle is the ultimate determination of the same fibre, for the latter terminates in it. Therefore the first and the last, or the two extremes, cannot but mutually correspond to each other. Thus the cortex of the cerebrum and cerebellum is the agent, and the fibre of the muscle is the patient, in other words, is obliged to act according to the force impressed by the efficient cause. The motive fibre is the cause of action; the cortical gland is the principle causing the fibre to act. Thus the whole action of the body comes forth from the active force of the cortical cerebrum and cerebellum.

CHAPTER X.

There is not a cortical gland in the cerebrum but corresponds to a particular motive fibre in the body.

A single medullary or nervous fibre proceeds from every cortical gland, which fibre is conveyed into the body to take a share in some sensation, or in the production of some action; consequently is conveyed to its correspondent motive fibre. One and the same fibre cannot perform two offices at its extremities, cannot influence two motive fibres, for an indistinct action would be the result. For this reason there is the same luxuriant supply of cortical glands in the cerebrum, cerebellum, medull oblongata, and spinal marrow, as there is of motive fibres in the body.

CHAPTER XI.

The cortical gland of the cerebrum and cerebellum cannot act on its corresponding motive fibre of the body, without an active or living force, that is to say, without expansion or constriction.*

Much the same may be said of the artery, which cannot act upon the blood, or through the blood upon the ultimate parts of the organization, without the active force of the heart, namely, its systole and diastole; for when the heart stops, the pulse and action of the blood cease. So also the cortical gland, which is the smallest type of a heart, a true corculum; and without the expansion and constriction of which, the animal spirit could never be expelled, or excite the motive fibre to act. Absolute repose in the principle must be followed by repose in the effect depending on the principle. But experience proves that the cortical glands respire and animate, and thereby drive the agent spirit into the extremes of the muscles. The cerebrum perpetually rises and subsides, or animates, which action can only begin in the cortical glands, and not immediately in the vessels and fibres. This is apparent from the phenomena of apoplexy, epilepsy, catalepsy, and the several diseases affecting the brain. The moment the arteries, or even the veins, of the brain are obstructed, and the cortical glands are from any cause deprived of room for action, the action of the muscles and the sensation of the organs cease.

CHAPTER XII.

The cerebrum is articulated and subdivided in such wise, that it can excite to action a greater or lesser number of the cortical glands, and so produce by the muscles any action that it pleases.

The cortex of the cerebrum is so divided and subdivided as to enable every several gland to expand and contract; likewise a greater or smaller number of glands, or a complete group, or even the whole at once. Winding channels, furrows, depressed lines and free spaces intervene between its parts, and distinguish each partition. The cerebrum has the power of rendering active any fibres or forces that it chooses, and therefore the motive forces of the body. It follows that it can animate or excite to action an entire muscle at one time, part of a muscle at another, and a second muscle and a part of it simultaneously with the first: also that it can in a moment transfer the action from one muscle to another, and so produce the form of any action harmoniously and delightfully.

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* See the note p. 4, above.—*(Tr.)*

CHAPTER XII.*

Voluntary action is a special and particular animation or excitation of the cortical glands of the cerebrum, subordinate to its general animation.

The fact of the expansion and constriction of the whole cerebrum, in no wise hinders its parts also from expanding and constricting one by one in a different manner from the whole. No general motion or action ever hinders or prevents special and particular motions, but rather facilitates them. The circumstance of an organ being capable of rising and moving by itself, depends entirely on form, that is to say, on position and connexion of parts. The situation and connexion of the cortical parts of the cerebrum is such as to allow of this; and hence its voluntary endowment. But when the cortical glands are as it were tied and compacted together, and their finest interstices and divisions obliterated, as in sleep, lethargy, carus, then this voluntary faculty or activity ceases. As soon however as they are again raised up, which takes place in waking, they all rouse to voluntary action. It is therefore the animation of the individual glands that produces action; for by this animation the animal spirit is transmitted into the motive fibres wheresoever they are grouped or situated. It would therefore be a worthy enquiry to institute, where the cortical glands are situated in the brain that correspond to one or the other set of motive fibres in the body; *i. e.*, whether in the vertex of the brain, in its border, or in its very substance?

CHAPTER XIII.

Spontaneous and natural action proceeds from the general animation of the cerebrum and cerebellum, undistinguished by any particular animation.

Spontaneous and natural action are opposed to voluntary; the former being general, consequently indiscriminate, indistinct and obscure, while the latter is discriminate, distinct, and peculiarly the attribute of parts or singulars. The cerebellum is not divided into masses, limbs and groups of parts, all distinctly moveable, in the same manner as the cerebrum; and hence it is that the action of the cerebellum is natural, but that of the cerebrum voluntary; for the same reason also the action of the cerebrum is natural, because general, during sleep. The peculiarity, however, of the action of the brains in different animals, and of the actions of the medulla oblongata and spinal marrow, is amply shewn by the form and state, or by the situation, connexion, and coexistence of the cortical glands and the muscular fibres corresponding to them. It is the form which makes everything what we find it to be. Moreover the cortical glands of the cerebrum, enjoying, as they do, the power of separation, may be put on the stretch to any particular degree, as in the waking state. It is worthy of remark, that the general animation of both the cerebrum and cerebellum, causes the muscles all over the body, (with the exception of those of the lungs and heart,) although perpetually in action, to keep their equilibrium by means of their antagonists.

CHAPTER XIV.

Most of the muscles of the body are supplied with the fibre of both the cerebrum and cerebellum; and hence are capable of both natural and voluntary action.

We may infer from the action of the limbs and muscles of the body, that the fibre of the cerebrum, or the voluntary motory fibre, hardly ever runs by itself to any muscle, but is most commonly associated with the fibres of the cerebellum. Thus in the waking state all the voluntary muscles stand in perfect readiness to execute the orders of the cerebrum, while during sleep they live under the auspices of the cerebellum. In fact I scarcely think there is a single voluntary muscle that is not supplied also by the fibre of the cerebellum. And in the head itself the fibres are commixed in this wise. The fibres of the cerebrum marvellously intertwine and clasp with the fibres of the cerebellum, first in the annular protuberance, next in the neighborhood of the testes, and lastly in the spinal marrow. Indeed they may be said to run in wedded pairs in every nerve and in every muscle. This is especially manifest in the lungs, which breath by night as well as by day, whether the cerebrum is asleep or awake. So complete is the union of influences, that not a single act of respiration happens during the day, in which the natural and voluntary powers are not really commingled; as we may all observe by carefully attending to the play of our breathing. In fact respiration is exactly suited and proportional to the state of the cerebrum, including the animus and mind of that organ. Some of the viscera of the body, however, are purely influenced by the fibre of the cerebellum, as the pharynx, stomach, intestines, mesentery, heart, liver, pancreas, spleen, testicles, epididymides, &c. Other viscera again partake equally of the fibres of both the brains, as the trachea, lungs, and eyes: and there are others in which the fibre of the cerebrum prevails; as the muscles of the head, neck, chest, abdomen, arms, loins, legs, feet, fingers, &c.

CHAPTER XV.

Action is determined by the cortical glands by the process of expansion and constriction; nevertheless, the power that expands and constricts the glands, or excites them to act, resides within the glands themselves.

The expansion and constriction of the glands, causes the expression of the animal spirit into the nervous fibres, and through them, into the motive fibres; and action is the result. In this way the gland is determinant of actions. The gland itself, however, must be determined by some relatively intimate and higher force, for it cannot determine itself. In the gland then there is a living element, which can will, enjoy power, and also act; that is to say, which can in a moment excite the glands to act in one distinctive manner. The cause of action is still therefore a matter for deeper enquiry, and when we institute such enquiry, we find a prior cause in a certain purer, more intimate and simple cortex, which is contained in the gland itself as in its own most diminutive brain. We have treated already of this simpler cortex, and shewn that our intellectual or rational mind resides in it, whose office it is to perceive, think, conclude, will, and determine into act. This gland is furnished besides with its own most simple fibrils and vessels, and assumes different states according to the changes of the mind. Therefore the mind itself is determinant of the action of the gland, and this, of the action of the muscles. But the first determinant of all is the soul, without whose consent nothing whatever can take place.

CHAPTER XVI.

We view and contemplate with the mind the whole action before it exists.

Compound actions exist by the motion of the different muscles, and of the different motive fibres therein. The muscles and fibres are determined by a higher power and force. This power and force reside in the cerebrum, which is the source whence actions are derived. The cerebrum has the power of thinking and willing; the body on the other hand has the power of acting, and of executing thoughts. Hence when the cerebrum is injured, obstructed, or clogged, the faculty of thinking and willing is lost; and therewith the faculty of acting is lost in the body; as we find in catalepsy, epilepsy, apoplexy, lethargy, and other diseases. And as the actions of the body proceed from the cerebrum, so they proceed undoubtedly from the mind of the cerebrum. Even speech itself, which is a joint action of the tongue, lips, palate, larynx, trachea and lungs, never exists without premeditation, or a previous view of what is to be said: therefore the character of thought determines that of discourse. Walking, jumping, the tossing of the arms, gesticulation, change of countenance and expression, and other actions, are not of spontaneous origin, but come by command. The body, which is commanded, merely obeys. It follows that we embrace in the mind in the first instance the whole action of the body.

CHAPTER XVII.

An action is an idea of the mind represented in the body by the ministration of organs; hence the whole body is moulded to the image of the operations of the mind.

The harmony subsisting on both sides between the mind and the body, has been a subject of anxious enquiry for many ages. We find every moment, as a matter of experience, that the organic frame rushes into action corresponding to the foregone ideas of the mind; which proves that something which is incorporeal or immaterial, excites the heavy mass of the body to all the numerous acts and operations that it pleases. This cannot be ascribed to mere correspondence; for action and motion never can exist without implying an active force actually impressed. It is clear from what has gone before, that there is no thought without a change of state; and that this change of state takes place in the cortical gland, from which the fibres are derived; also that the cortical gland must be actually expanded and constricted, to drive the animal spirit into the fibre of the cerebrum, and so into the motive fibre of the body. Experience completely establishes the fact, that the muscles are actually dilated and constricted, and the limbs in this way set in motion by means of the tendons. Hence it appears, that all things in the body are so framed as to act completely at the bidding of the mind; *i.e.*, that the body is the image of the mind's operations. And thus in setting about to form or create its body from the ovum, the soul views in itself or its ideas, all those operations as already existing in act in the body; the soul regards the body as if it already saw, heard, tasted, spoke, walked, moved its arms and its fingers, and its viscera likewise, its heart, its stomach, its intestines. The result is an answerable organization, as the marking of the fœtal body is the result of the imagination of the mother. Nature which is the instrumental cause, is so constituted, as to obey the spiritual essence in all things;* as also afterwards, when the body is entirely formed, in actions themselves. In the soul then there is everything in potency that there is in the body in act. The very body declares every moment that it is the image of the operations of its soul.

CHAPTER XVIII.

Any habitual action recurs in a manner spontaneously with the whole of its form by virtue of the mere force impressed by the mind, almost in the same manner as a natural action.

As appears from speech; for the tongue, the lips, the cavity of the mouth, and the trachea, fold and roll, without a moment's hesitation, to enable them to articulate the whole of the voice or sound. They run into actions that have become habitual; which actions, however, must have been often repeated and have become familiar previously. The like takes place in singing. So also the eye turns in a manner spontaneously to objects. And again the fingers run automatically over the strings of the lyre, or the harp. During the action of walking also, the feet and the footsteps once entering the way, go on without any notice. Not to mention the gestures and actions of harlequins, actors, and other performers; in all of who ever, every act must have been acquired, before it can be continued in this manner; after which habit becomes second nature. But the mode in which this is brought about, is explained by the anatomy of the cerebrum, medulla oblongata and spinal marrow. The cortical substance of the cerebrum sends down fibres innumerable to both these marrows, which it associates with their own proper fibres. Thus the medulla oblongata and spinal marrow are compelled to act at the bidding of the cerebrum or of the mind in the cerebrum. And when this harmony is well established by frequent use, then the cineritious substances of these marrows, at the first sign from the cerebrum, rush into convenient actions, as if the cerebrum commanded them all. The precise organism, however, for carrying out this effect will be explained in the Parts on the Cerebrum.

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* The above sentences involve an important doctrine in reference to nature as the habitation of human society. For as the body is constructed beforehand with express reference to all the natural actions that the individual will ever have occasion to perform; so nature, and the human organization considered as a part of nature and a mutable subject of the providential series, are constructed with a foregone reference to all the states, arts and requirements, that humanity, as a created thing and a compound individual, can possibly imply. The world then, in its fundamental conception, contains a promise of the express gratification of every good natural affection, every true natural thought, and every just sensual want in its minutest detail, and in its entirest compass. Neither the body nor the world are in themselves hindrances, but on the contrary means, to fulness of satisfaction and universal competence, *Quærite et Invenietis.*—(*Tr.*)

CHAPTER XIX.

There is both internal action and external, and an actual harmony is established on both hands between them.

Internal action is thought and an attribute of the mind; but external action belongs to the body. Internal action or thought is performed in the innermost parts of the cerebrum, or in the purest organic or cortical substances; external action is performed in the outermost parts, or in the muscles of the body. Action is change of state; so also is thought; indeed the latter can have no existence apart from change of state in the cortical glands; nor yet can the action of the body, without a change of state in the muscles, and consequently in their motive fibres. Between these two actions a firm harmony is established by the fibres, which begin in the above-mentioned glands, and end in the muscles; so this harmony is actual. Even the manner in which the most delicate fibre with the most yielding spirit can produce such great and grave effects, may be understood if we consider, that in the whole muscle there is nothing substantial but the fibre, and that during every act of expansion, this fibre expels the blood, which is gravitating or heavy, and during every act of constriction, admits it. As this is done in the infinite minimal points of the motive fibre, and hence in all points of the muscle, so of necessity it is done in the whole muscle, and implies the action of the whole muscle. The compound derives all its force from simple substances and forces. The exceeding minuteness, the nothingness, according to our ideas, of that which can move masses in space, may be concluded from all the effects of nature, nay, even demonstrated by calculation.

CHAPTER XX.

There can be no force without action, no action without change of state, no change of state without an idea of motion: that which thence results constitutes an effect.

According to the common rule, force supposes action; action supposes change of state; and change of state supposes fluxion, which cannot be conceived apart from the idea of motion; again motion supposes an effect. Thus the sufficient reason for the actuality of the effect is contained in active force as the efficient cause. The soul or the intellectual mind* is the supreme force of its kingdom, and cannot exist without thought, which is internal action. This action, viz., thought, supposes a change of state in the cortical gland. This change of state cannot be conceived without change of the essential determinations, or the form; and hence not without variation of position and nexus in the simple fibres and other substances in the beforementioned glands; or without the idea of motion. The result is sometimes termed an effect, sometimes a phenomenon. Therefore the effect of internal action is external action; and the effect of external action is that which is produced by action, and intended by the mind: thus the end coincides and conspires with the effect. But I say that there can be no change of state without an idea of motion. It is true there may be such change without motion itself; for the existence of motion implies a centre, a circumference, different quarters, upwards, downwards, space or place; which cannot be predicated of the simplest forms; hence neither can motion, although the idea of motion may; but which idea, in accommodation to the understanding, must be fixed in objects that our senses can recognize as moved. Every entity has its distinctive quality from its form; from the same therefore it has the predicate of being either devoid of, or participant in, motion.

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* In the *Economy* the author makes a great distinction between the soul and the intellectual mind.—(*Tr.*)

CHAPTER XXI.

As action is change of state or of coexistents, so there is purely natural action, there is animal action, and there is rational action or action proceeding from the understanding.

Purely natural action in itself is devoid of all end and understanding, and is in fact dead and blind, because it does not appear to be at all determined by intelligence. Such is the action of the wind upon the sails of a ship, the action of a wave upon a rock, of light upon the eye, &c., &c. The action of gravity is also an instance of purely natural action. Animal action, however, constitutes instinct, and is found even in the human race; proceeding indeed from an intelligent source, or from the soul; although as this action results from a particular necessity, and the mind is not made conscious of it, it is said to be purely animal. Rational action on the other hand is an adjunct to some end that is foreseen and intended; hence it is performed designedly and purposely, and constitutes proæretic action, in which we see the end before the effect, or conjoined to the effect in such a manner that apart from the end the effect is regarded as of no account.

CHAPTER XXII.

Rational action is that in which an end is at once intended and foreseen, and which is free, and completely represents an idea of the mind.

Rational action has effects, only in order that there may [1] an end in the effect, or in order that the action may exist for an end. True intelligence, which is spiritual, regards the end for which it exists, and the end only. Thus the animal kingdom and the bodily system are formed, not for action alone, or for the effect of action, but for the end. The soul is in the intuition and estate of ends; the body of the soul, in the representation of effects, containing the ends which the soul contemplates. Effects are physical and bodily, and attended with motion; ends are spiritual, and devoid of motion. It is therefore necessary that the election of ends be free, in order that there may be an end to be produced by action, and that the action may be rational. Without election and liberty we should of course have necessity, resulting in animal or purely natural action; the subject being bound to one peculiar course of action; which is incompatible with rationality and voluntary power. Meanwhile when action is final, is for an end, the end so rules in the action, that the physical instrumentality which helps the end is almost lost sight of. Moreover we are so constituted as to be in profound ignorance of the mode whereby the idea of the mind, and the will, pass into action; in order that there may be nothing to prevent intuitions of ends from becoming actual. It follows from these considerations, that human actions are to be considered as spiritual and not bodily.

CHAPTER XXIII.

No action can exist but from a substance; consequently the nature of the substance determines that of the action: thus the substantial form coincides with the form of the action.

Internal action is the predicate of the cortical gland and its fibres, and thus it is the action of a substance; external action is the predicate of the muscle and its fibres, and thus it also is the action of a substance. Whether the substance to which action is attributed be simple or compound, it must be conceived as made up of an infinity of individual or simpler substances, which represent some form by their fluxion. In the nature of things there is no substance without a form, and no form without an idea of fluxion; hence the character of the substance determines that of the form, and the substantial form coincides with the form of action. This is the reason why the peculiar form of the substance may be inferred from the form of the action, and *vice versâ*. No muscle can do otherwise than act agreeably to its form, that is to say, according to the connexion, situation and position, and quality, of its motive fibres, of its belly, of its tendon, and of its membranes. But the form of the action cannot be perfect, or answerable to the mind's idea, unless the fibres of one muscle are capable of being commanded, and with them certain of the fibres of some other muscle, and so of several; which when called forth into motion produce a compound action, that represents a new form of action.

CHAPTER XXIV.

*All the substances of the animal body are organic, and formed, subordinated and coördinated, to enable them to represent in action all the possible ideas of their mind.**

The very formation of the animal body manifestly indicates what forms of action are capable of being produced. The organic body is created for no other end, than to live in acting, and act in living, conformably to the operations of the mind. The lungs exist to respire, to draw in the elements of the atmosphere, and to accommodate themselves to all actions. The heart exists to put the blood in circulation. The arms, the feet, the fingers, the scapulæ, &c., are meant to enable us to be active inhabitants of the earth. The other members likewise. From all and each it is clear, that substances are formed in the first instance, and all for the use that the mind foresees and intends. The soul regards actions as ends, or as leading to ends, and arranges substances as instrumental causes, that such actions may come forth at its bidding. Thus in point of actions, the body is a genuine image of the operations of the mind.

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* *Their mind!* This form of expression is, it must be admitted, somewhat awkward, and yet, after long experience in translating these works of Swedenborg, we have never been able wholly to give it up, or to find an adequate substitute. The truth is, that the philosophy of this author is the only complete reconciliation which the world has seen, of the soul with the body, and of matter with spirit. Now the body is not independent of the soul, but on the contrary is *the body of the soul*, nor is the soul independent of the form of the body, but is, by that form, *the soul of the body*. This mutuality and interdependence are constantly expressed and implied by the author in these little words, *its body*, *their body*, &c., &c., where we should be inclined simply to say, *the body*, and so forth. If the new phrase should have the effect of continually reminding the reader of the oneness of things spiritual with things natural, and of the presence of all things in each, it will be well worth while to sacrifice somewhat of idiomatic propriety to so important a use.—*(Tr.)*

CHAPTER XXV.

Actions are perfectly rational in proportion as the mind can the more purely regard the actions of its body, and the effects of those actions, as ends.

It is the mark of true rationality to have an end in view in all we do, or to do nothing without an end. Only an intelligent being can regard ends, and intend and promote them by actions. We are both spiritual, and corporeal or material creatures. The spirit respects ends alone, and in so doing, effects follow of their own accord; nature being so constituted as to serve the intelligent being as an instrumental cause. Nature is the handmaid of the spiritual essence or intelligence; for the lower form is submissive to the higher, and in fact produced by it, to comply with its bidding. Such is the relation of the body to the soul. When the spiritual dominates, the fruit of action is spiritual also; and the reverse is also true. We must carefully distinguish, however, between rational ends and natural ends. Truly rational ends have in view the salvation and happiness of the soul, while natural ends regard the delights and comforts of the body. In the former ends we foresee no effects unless we clothe our ideas with earthly images, and bring faith to bear; but in the latter ends we foresee effects because they please the external bodily senses.

CHAPTER XXVI.

Actions are perfectly rational in proportion as the mind views and comprehends a greater number of middle ends conspiring to an ultimate end, and so disposes and arranges them all as that the ultimate end shall necessarily come to pass.

This constitutes prudence. Some persons there are who entertain a very small number of ends at once, and seize upon the middle as if they were the ultimate ends. There are others who regard no end in universal nature as ultimate, but all natural ends as means to an ultimate end beyond nature; and these persons are more perfectly rational than the former, and their actions are likewise more rational. The comprehension or simultaneous regard of a number of ends that terminate in nature, is the predicate of intelligence; but the comprehension of spiritual ends, or of the ends of ends, is the predicate of wisdom. The first of these faculties is human; the latter is divine, and must be owned to be the gift of God; for of ourselves we are intelligent indeed, but not wise.

CHAPTER XXVII.

There can be no purely rational action but what proceeds from the all-wise providence of God.

Action can no more be predicated of God, than motion, of the soul. God is above all action, although without Him there is no action. There is no action without change of state, and no state without form; but in God there is neither form, nor state, still less change. All these predicates are far below the Divine Essence.* We cannot conceive of action or change of state in the soul without the idea of a fluxion of parts, and without an idea of motion, and yet the soul is devoid of parts, and devoid of motion. How then can we conceive and express the Divine Essence, which is as far removed from the predicates of action, as the action of the mind is removed from the predicates of motion. But as God is the true wisdom, and as He is the true end, from which all things originate, through which all things proceed, and to which all things tend; and as the universe is the world of the effects of His providence, so it follows, that there is no natural action even but descends from Him; for in God we live, and move, and have our being. Thus that action is purely rational that proceeds from the all-wise providence of God.

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* There is, however, a Divine Human Essence in God, to which Form belongs preëminently: see the author's Theological Works for the correction of his statement in this place.—*(Tr.)*

CHAPTER XXVIII.

Many actions are simulated, and answer to no idea of the mind; but nevertheless an intelligent observer, by considering the form of several actions, and their mutual bearings, may discover the mind or intention that lies in them.

The mind has many ideas, both successive and simultaneous, and many ideas are proposed to the will; yet none are determined into action but those that are the means to some prefigured and purposed end; the others do not go forth or transpire, being regarded as contrary to the end. Therefore, though the mind thinks one thing, and the body does another, still the action does not cease to be peculiarly an idea of the mind, although different from that which is proximate to the end. The mind, however, is brought to light when actions are properly surveyed one after another, or if they are reduced to a species of equation, and the idea of the ideas is evolved analytically therefrom; which process presupposes an intelligent and sagacious agent.

CHAPTER XXIX.

So long as we live in the body, our voluntary or rational actions are never pure, but on the contrary, always mixed.

Our understanding is not pure; and so neither is the will, which is the finish and realization of the thoughts, or the ideas of the understanding. We perceive hardly anything more than what finds its way into the mind through the inlets of the external senses, and we desire hardly anything beyond those objects that flatter the senses and give pleasure to the body; hardly anything beyond earthly and natural gifts. And as we desire natural ends, which constitute the lusts of the animus, so the desires entertained of ends by the mind cannot fail to be impure. That spiritual principle which is involved in the understanding is scarcely known to be present otherwise than as a matter of mere contemplation, and is so enveloped in material ideas, that the desire of it is almost never the object that determines the will. Such mixture existing in one and the same mind, it is no wonder that our will or acts cannot possibly be termed pure. We even experience this in the state of our bodies. Our very will and voluntary powers, our desires and lusts, destroy the body and subvert its economy, and hurry it into disease, old age and death: the spiritual principle is the only resource for repairing the mischief.

CHAPTER XXX.

The thoughts of the mind are concentrated in a will, that embraces the mind's ideas, and to which will the actions of the body correspond.

According to the series of our rational mind and the mental operations, we in the first instance perceive the images of the senses;* we then turn them over on all sides, and revolve them, that is to say, think; and then from the stores of the memory we take out a number of ideas associated by similarity; afterwards we combine these scattered elements of thought, and reduce them to a particular form, which constitutes judgment: we then conclude that the ideas of the mind centred in the judgment, are to be determined into act, or to be represented by actions. This is what we term, a conclusion; and to this conclusion a certain force is communicated to enable it to issue in action. This conclusion is a will. The will therefore involves in a concentrated form all the elements that there were in the thought and judgment, and in addition a force constantly acting to ensure determination to action.

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* This scale of the mental faculties should be well attended to by the reader who desires to understand the author's metaphysics.—*(Tr.)*

CHAPTER XXXI.

Will may be regarded as parallel with effort, action being parallel with motion.

Any action which does not come from the will, or which contains no volition, is not a rational, but an animal or natural action; therefore will is perpetually present in rational action, as effort is perpetually present in motion. When will ceases, action ceases also; and the character of the will determines the character of the action; and the same remarks are applicable to the mutual relation of effort and motion. And hence it is that action is never looked at physically according to the form, but according to the will, that is to say, according to the ideas of the thought, and according to the intention or end. The action of two individuals may be perfectly similar, and yet not similar, if the will does not similarly correspond to it in both cases. Therefore what effort is relatively to motion, that will is relatively to action.

CHAPTER XXXII.

Will under the aspect of effort involves the various directions and velocities of action regarded as motion.

Experience proves the fact. For by a foregone will we are enabled to direct our actions to any object whatever, and to any effect, or end; and in like manner to determine them with any rapidity we please. To ensure the perfect form of action as a result, we can call into exercise one set of muscles at the same time with another; and one set of muscular fibres. This is manifest in speech; thus we can heighten and we can lower the voice; we can accelerate our utterance, or bring it to a stop. And so also in our other actions.

CHAPTER XXXIII.

Unless the will be resisted, it breaks forth in undisguised action, as effort, in manifest motion.

Effort corresponds to will, motion to action, and resistance to impossibility. Force consists in a continual effort to action; and action constantly follows from force, unless resistance interposes. Impossibilities, of which, as of resistance, there are various degrees, are the resistances that curb and limit the will.

CHAPTER XXXIV.

The Founder of the universe has decreed in his Providence, that although the several parts endowed with force shall exert the effort to act, nevertheless they shall be resisted so far as to prevent them from acting otherwise than suitably to the order of nature. So also in the animal world.

Every particle of the air and ether has its own given force, but is resisted by its fellows and neighbors, and prevented from acting contrary to the order of nature; hence all things in the natural universe are in a state of equilibrium. So in the animal microcosm the will is the analogue of effort in the macrocosm; and this will is more or less coerced by impossibilities, which prevent it from breaking forth in actions. Thus infinite means are provided by the Founder of the universe for offering resistance to human wills; of which means we need only instance civil laws, and the forms of society, whereby individuals are kept within the bounds proper to their sphere.

CHAPTER XXXV.

The force that is contained in the will comes from the desire of some particular end, and thus gives birth to action.

Apart from the desire of an end, there is no will; for there must be force in will before will can properly exist; this same force, or this desire, rules also in thought and judgment themselves: therefore those who are destitute of all desire are devoid of will also. The desires of the mind are directed to an end, but those of the animus are lusts, and those of the body are pleasures; the desires of the soul, which are pure loves, preside over all the rest. Thus the heat and fire, nay, the life of our actions both internal and external, consists of mere desires, without which we should have no life in our actions, and no action in our lives.

FRAGMENT ON THE SOUL.

KIND READER!

I WAS for some time in doubt whether to comprize in a single volume all my long meditations on the soul and the body, and their reciprocal action and passion, or whether it would be better to divide the work into numbers, and publish it *seriatim*, after the manner of transactions. To declare the nature of the soul, to exhibit its state, to shew the mutual intercourse and action subsisting between it and the body, and the connexion of each with each in the bonds of harmony; in other words, to display philosophically, analytically, geometrically, and anatomically, the entire animal kingdom and its parts, with the functions and offices of each,—this is a labor of some years, and must extend over several volumes. And as I suspected and indeed foresaw that it would be utterly impossible to accomplish so vast a work at one blow or with a single effort, and and that if I attempted this I should probably fail in the middle, and in despair of reaching my journey's end, should sink under the burden, or as the poet says:

> Impatiens animi lasso pollice sisterem opus :

so, under the circumstances, I have thought it most prudent to divide the labor, and to take up my pen at short intervals, allowing myself occasionally a little respite, to draw breath, and enable me to attend to my other duties. For the mind is even as the pen: too much usage blunts its point, and wears away its fineness. Such, gentle reader, is the reason which will move me to recur at frequent intervals to the task I have prescribed for myself, and to intrude myself often upon your presence, probably not less than five or six times a year, with my publications, or as they may properly be called, Psychological Transactions. By this means, I hope, after a few years, to gain the end, and to be in a condition to declare the state of the soul, when its connexion with the body is dissolved by death, and it is left to its own disposal. In the meantime, most earnestly desiring for the reader both long life and well being, I remain, his very devoted and obedient servant,

I. S. E. G. O. F.

TRANSACTION I.

GENERAL REMARKS ON THE SOUL, AND THE HARMONY BETWEEN IT AND THE BODY.

§ 1.

The mind never reposes truly on any system concerning the intercourse and harmony between the mind and the body, if that system supposes an unknown, incomprehensible element. In all subordinate series of causes, from the first cause to the final event, we have no right to assume anything, unless its credibility be undoubted, and its truth ascertained. In a chain of argument, if there be one questionable link, the whole of the subsequent series depending thereupon, and the conclusion also, will be similarly questionable. If a number of unknown or occult elements exist in different parts of the chain, the doubt attaching in the end to the induction founded upon such premises, must be still more considerable. The interposition of the unknown quantity not only engenders and constitutes indistinctness and confusion in the general idea, but places every idea in ambiguity. Uncertainty is the parent of uncertainty. The bottom or foundation of a house determines the firmness of the superstructure. The strength of the first or middle link in a chain, determines the efficacy and power of the subsequent links, and of the chain itself, or the hook at its extremity, to sustain the weight which is required. The fai of a single part amounts to a loss of power in the whole. As is the antecedent term in a syllogism, so is the conclusion; the major or minor must be demonstrated, for the other to be valid; for the validity of the consequences is in proportion to that of the premises. If of several numbers submitted to calculation, one be unknown, the sum or quotient formed by their addition or division will present the same constant character; an equal error will run through the aggregate or product to that in the separate constituent numbers. One dissonance present in a harmony will often produce the discord of the whole. In a word, the conclusion and the end must respect all the premises, otherwise the effect would not be similar to its causes. Where the means have no evident likeness to the antecedent causes, the end is placed in doubt, or assumed doubtfully. Where the connexion and quality of causes does not plainly appear in the progression of the means to the end, the hope of an effect to come is destroyed. This then is the hotbed of so many hypotheses, that in the analysis of causes, uncertainties are taken for certainties, and the mind attaches itself to the images of occult objects as to the spectral appearances of a dream. The consequence is, that such hypotheses are rejected on the same principle as they are acknowledged, and the affirmative and the infirmative, the negative side and the positive, make equal claim upon our credit. The truly rational mind, however, in no case depends upon the *ipse dixit* of the speaker, but upon the truth of what he says. The authority that is valid for it, is the truth of the matter. The soul, as the perpetual mover of the bodily machine, continually agitates the fibrils of its organs, and elicits or draws therefrom abundant images and signs, but only those which are similar * * * *

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[Two pages of the MS. are lost at this point.]

* * * * to plant their standards. But as the judges themselves depend upon the ideas or images which they have, and these ideas and images upon their corresponding internal sensorial organs, and these again upon their external organs and external senses, and the senses upon their visible world, so we may easily foresee and guess what opinion will prevail. In fact the opinion is put forward and pronounced to suit the conceptions and enlist the applause of the vulgar, and to win the judgment founded upon the ideas of the organs. But the organs are ignorant of everything that outlies their particular sphere of sensation or perception. Yet on their testimony, on the faith of their declarations and proofs, the mind hesitates not to conclude, that whatever is internal to the minimal ray and unit of sensation in the aforesaid organs, must be the very simplest of things, and have originated from nothing; and that in this way the soul itself is not a compound but a simple substance, because its qualities are inaccessible to the organs of our senses. This opinion the vulgar applauds and subscribes. Nay, there are not wanting those who assume an attitude of menace, and use threatening expressions and ferocious gestures, against all who attempt to overpass the ordinary pale of knowledge, or who do not kindly take their own view of the question. Just as formerly was the case, when the learned began to suspect that the earth was not supported by columns, or fixed immoveably in the centre of the heavens, but rotates on its axis, as well as performs an annual revolution about the sun; and that the sun is stationary in the centre of the solar vortex. Or as when the mind, diving beneath the appearances of the senses, wisely concluded that our antipodes are subject to a pressure towards the centre of the earth, just as we, who are antipodes relatively to them, are subject to the same; and that all the radii running from that centre, are perpendicular. But those who are ambitious to be no wiser than their senses, proscribe the knowledge of principles like these, and they try to scare and prohibit the philosopher from their cherished haunts, wishing the evidence and decision of the senses to settle every question, and to be the limit of nature's depth and man's penetration; and the goal of all knowledge and wisdom to be set within the purely animal sphere, far from humanity and rationality. But the soul is

conclusion a certain force is communicated to enable it to issue in action. This conclusion is a will. The will therefore involves in a concentrated form all the elements that there were in the thought and judgment, and in addition a force constantly acting to ensure determination to action.

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edly this system that rules the present hour, and distances all competitors, like a lofty cypress growing from the sepulchre of Leibnitz, and in a few short years towering so far above the other trees. The following then is a brief statement of it.

There is in the soul a unique force, namely, a force representative of the universe, and this force produces all perceptions, which perceptions have their sufficient reason in a force representative of the universe. In other words, there is in the soul a series of perceptions and appetitions,* and therefore of volitions; but in the body a series of motions; and the two series harmonize and conspire, each with each, by virtue of the respective natures of the soul and the body. The above force is proper to the soul, independent of every external principle, and of the body itself, and thus it is the force by which the soul produces in one continued series all perceptions and appetitions. The soul would represent perceptions and appetitions in the same way that it now does, were there no body, or no visible world in existence. This force is bound to observe certain laws; consequently there are laws of perceptions, as well as of appetitions, and the law of sensations contains the essential determinations of the soul. And the law of imagination must have some share in the law of sensation, and *vice versâ*. There are also laws of appetite and antipathy in the soul. God has preëstablished a harmony between the soul and the body, insomuch that he has adjoined to the soul a body capable of undergoing series of motions agreeing with the perceptions and appetitions of the soul. He has not preëstablished any appetitions in the soul, but only a harmony between the motions excited in the body by the impressions made upon the sensory organs and the perceptions of the soul; or between the voluntary motions in the body and the appetitions of the soul; this, however, apart from any real dependence of the soul upon the body. The material ideas to which sensual ideas correspond, depend upon impressions made by sensible objects upon the sensory organs: and the voluntary motions that correspond to the appetitions of the soul, depend upon the motions of the nervous fluid circulating in the motory nerves. By virtue of the mechanism of the body there arise from the material ideas of sensible objects, motions answering to the volitions and appetitions of the soul; apart from any immediate extrinsic determination. Consequently from the series of motions in the body, a reason may be given for the origin of the perceptions and appetitions in the soul, and for the peculiar nature and quality of such perceptions and appetitions; and *vice versâ*. The presence of material ideas in the brain contributes in no respect whatever to produce them. Moreover, all these predicaments may be understood, without supposing the soul to exert any action on the body: nay, they all happen naturally; and even the fact of mutual intercourse may be intelligibly explained by the very nature of the soul and of the body. And nevertheless, the necessity of the motions that correspond in the body to the appetitions of the soul, does not deprive the soul of liberty. Lastly, the mechanism of the body is incomprehensible, though still a subject for probable arguments. It is also stated to be a tenet of Leibnitz, that all spirits collectively constitute the city of God, which is the moral world in the natural world; and that there is a perfect harmony between the physical kingdom of nature and the moral kingdom of grace. Not to mention several other doctrines, respecting which we refer the reader to the Master himself and his followers.

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* "The action of the internal principle that causes the change or the passage from one perception to another, may be termed an *appetition*." (Leibnitz, *La Monadologie*, n. 15.)—*(Tr.)*

It is commonly known and admitted, that the soul is capable of exercising sensation, perception, appetite and will, and endowed with the power of producing all these as its own peculiar qualities: that between the soul and the body some relation is necessarily implied, which may be termed intercourse; inasmuch as material ideas, as they are called, are consentaneous with the sensations and perceptions of the soul, as also are the motions of the body with the appetitions and volitions of the soul: that the reason is given in perception, why both sensual and material ideas arise; and *vice versâ:* also that the said qualities of the soul have their own laws; and that there is a series on both hands, in the body as in the soul, agreeably to which, and in conformity to these laws, all these predicates happen in successive order. And that in the sensory organs and the body there are similar modes and motions; with many other particulars sanctioned by experience, and which our very senses plainly indicate to the soul, in so far as it is rational and conscious of the senses. Nay, these points are attested by effects upon which the soul is capable of reflecting. Those who have the least penetration, even though they be clowns, if they are not without the feeblest glimmer of reason, know perfectly well, that ideas and images are formed on the model of the objects that enter from the visible world through the organic inlets of the senses; and that there is in the organs a species of remote sensation, which appears however to be a kind of proximate sensation: that motions are produced in the body by the instrumentality of the muscles, nerves and fluids; and that all things have their given efficient causes, or active forces; and the causes, given laws; and so forth. But what then? These are not occult or hidden points. They are presented to every soul by its senses, and the soul is bound to give credit to clear evidence, experience, and fact. They do not delay or stop any mind desirous of knowledge. But the mind, as we all know, longs to overpass such clear pieces of admitted knowledge. Of the existence of harmony she is fully aware, but the matter of enquiry is the quality of this same harmony. The mind is in no way stirred by the words, sensation and perception, the things to which they correspond being too well established to cause the slightest uneasiness of doubt. Nor yet by the assertion, that the soul exerts appetite and will, antipathy and aversion; for nothing can be more frequent, than our wishing for what we like, and wishing for the absence of what we dislike. Nor does the mind raise the least doubt respecting ideas and images, as being formed with a reference of congruity to the perceptions of the soul; and *vice versâ*: nor, therefore, the least doubt that the reason of the one is contained in the other, just as the reason of the quality of a causate lies in the cause. Nor again has the mind a moment's difficulty in admitting, that every affection and quality has its appointed laws; because these laws, or the fact of their existence, is dictated to us by the variety and constancy of mutual operations subsisting between the body and the organs on the one hand, and the soul on the other. Moreover the mind cannot deny the fact of series and connexion, and of a particular order, exhibited as one thing passes by successive stages into another; for we know that appetition cannot be present without previous perception, or will without previous appetition. The modes and motions in the sensory organs and the body are plain from every action and effect. We need not open our eyes widely to see these truths; any one may discern them by a sidelong glance. It follows from them, that the efficient sufficient causes, and forces, in the soul as well as in the body, must both be present, to create, or to accompany, the act or effect. The mind, however, will not dwell long on trite and obvious matters. She asks impatiently, as I opine, what these declarations point to. She asks whether they furnish a clear explanation of those subjects that she longs to know? whether the new system introduces us to any deeper knowledge of ourselves? That she feels and perceives, she knows already, because she *does* feel and *does* perceive. But she wants the cause; she desires to perceive the relation of quality. Judged by this requirement, what does she perceive? Is it enough to know that we perceive? Poor and barren would be the faculty of reason, if it only knew that it knew! And as the mind passes by a series or law, first from perception to appetition, and then to will, the soul feels the progression, but is unaware of the mode and moving principle, as well as of the causes which enable the transition to take place from one affection to another: and still it remains throughout in ignorance of itself, because in ignorance of causes, and the more will so remain, the more deeply and predeterminately* systematic it becomes. And when the question is put, what harmony is, and what the distinctive nature of harmony, and of laws, motions and forces, here again the mind knows nothing beyond the bare fact of the existence of forces, motions and laws. But it is not enough to be conscious of these and of itself, for this is an animal endowment, and it may indeed be predicated of the senses that they are conscious of objects presented to their organs. On the other hand, the rationality of the mind implies, that it also becomes conscious of causes by its analytic faculty. But in proportion as the soul desires to bestir itself purely and wisely, and attempts with earnestness to extort from itself an account of its own operations and those of the body, in the same proportion the [preëstablished] system struggles and resists, and hinders all solicitous and deep enquiry. In fact it at once shuts the door in our faces, and opposes its bolts and bars to the mind desirous to advance into the sciences, and plants hedges and fences on every road and round every field, to prevent the traveller from proceeding. This system, we say, defends a harmony preëstablished by God, and forbids us to go further, by opposing an occult quality. And to hinder the mind from breaking through or leaping the fence, it affirms that all things are carried on apart from any mutual dependence, and entirely takes away the connexion between the soul and the body. The laws and series themselves, whether in the purest being, namely, the soul, or in the compound and material being, I mean, the body, it pronounces incomprehensible and impenetrable; consequently, not perhaps similar to those, although they are natural, that appear to exist in the visible world, and are reduced geometrically and mechanically to laws and rules. Forces likewise, of which there is but a single one in the soul, and that one, as we have seen, representative of the universe. Wherever the mind turns, it finds some occult barrier opposed to it. This prohibits it from knowing anything beyond what it chances to know experimentally. Stand on what bank or shore you please, an abyss is conjured up before you, at which perforce you shudder as at the yawning sea; until you are too glad to admit, that the soul, with all its rationality, perception and light, will perish and founder in a thick night of occult qualities, if it unfurls its canvass, or tempts the deep. Thus the system dissuades us all from putting forth upon the waters, as having itself neither oars nor rowers at command. Therefore on the other hand I shall do my best to shew, that this philosophy is stuffed with innumerable occult qualities and with nothing else, and aims to overwhelm the mind and blunt the intention; together with other points which I think it wise to pass untouched at present. But if the streams be thus arrested, and if we are to fly at once to the arms of ignorance as a refuge, there is an end to all rational philosophy and psychology, nor can we move a step beyond that ordinary world which is obvious to the external senses. Then we must give up all hope of borrowing any light at any time from science and scientific experience, and of penetrating the causes of things or attaining wisdom. Moreover we must submit to the yoke of authority, and be sold into slavery, until the mind and philosophy almost lose the recollection of breathing the free and pure air of heaven. Oh! the hatred with which we have pursued the atoms of the ancient philosophers! Oh! the laughter and the hissing with which we have saluted their occult qualities, and driven them from the stage, and endeavoured to undermine and demolish their systems and inventions! With this view, at the present day, we have attempted to decorate the entire stage with experiments and phenomena, and to proffer the torch and light the way; simply that occult nature may be drawn from its abyss and den of refuge in human ignorance; because we are ashamed of living any longer in the spectral darkness of the ancients. On this account we endeavor to elicit all kinds of knowledge from experience, and to bathe our eyes in healing waters, to clear them of those specks and clouds that cover the pupil and obscure our sight. And even though we fail, yet are we supported by the hope, that at any rate our children's children, by our industry and effort, will enjoy the introspection denied to ourselves, and see deeper than we into nature, and the occult sphere of causes; inasmuch as we transmit to them numerous means and indications of knowledge, like blazing torches in the night of ignorance; and leave them our own possessions for an inheritance.

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* *Præstabilitius.*

But dismissing these considerations, let us proceed to examine this system more exactly; to weigh it carefully in the balance; to open the fruit, and note the number and description of the occult qualities that it contains. Recurring to our preliminary abstract, the first point that presents itself, is the following: *There is in the soul a unique force, namely, a force representative of the universe.* For my part I find it difficult to explain without an interpreter, what, and of what nature, this unique, proper, essential and natural force, named representative of the universe, can be. My mind is perplexed as by an obscure oracle when I ask myself the meaning of a representation of the universe by an efficient force. Nor am I long-sighted enough (perhaps adequate words were wanting to express or fully convey the author's meaning) to know what is intended by the soul having the power to produce an idea of the whole present universe, without guidance from an external and higher principle. It means, if I understand it aright, that the soul is the efficient sufficient cause of the whole of perception; or that it is a living tablet or mirror, with a power or force to represent the objects of the universe; or that there is a force in the animal mirror which causes everything to be represented after a universal manner; or that there is a bare force. I trust the reader will forgive me for trying to approximate to the meaning by a guess, and render it more clear to myself. But taking any of these explanations, without however admitting them, the upshot is, so far as perception is concerned, for it is plain beyond cavil, that there is in the soul a power of acting and perceiving: over and above this well-ascertained fact, all is occult quality.

This force produces all perceptions, which perceptions have their sufficient reason in a force representative of the universe. When one is in perplexity as to the nature and quality of this force representative of the universe, all the propositions resulting from it, are ambiguous and obscure in their meaning. Now no one knows its quality; nay, the reasoners are not agreed, whether there be a force representative of the universe and unique in its character, or the contrary; or whether such a force can produce perceptions, (which in this case it would owe to itself alone, and to no exterior power; although not originally so, yet principally so now; and consequently perceptions would be congenital or coexistent with such a force; inasmuch as the force is single or unique, and excludes the notion of dependence on the body, and nevertheless is sensible, because it perceives and is self-conscious). But I will not consider this in detail, because it is not my object to be studiedly hostile, but only to indicate, that by means of this system all quality terminates in occult being. A simple man, little apt in expounding riddles, I confess I do not know the meaning of the same force producing, the same representing to itself, and the same feeling and perceiving the thing represented; or of the same force effecting, and comprehending the effect; when yet this force is most simply single, and the soul a pure substance. Were belief an act of good will, I would cheerfully give mine; but I am not acute or clever enough to see anything here beyond occult quality.

There is in the soul a series of perceptions and appetitions, and therefore of volitions; but in the body a series of motions; and the two series harmonize and conspire, each with each, by virtue of the respective natures of the soul and the body. This comes home to the understanding, and we all believe it fully. It is most true that there is in the soul a series of perceptions and appetitions, answering to the series of motions in the body; and that these series harmonize, accord and coincide. It is a palpable truism, plain as if written on the sun, that we do perceive, that we do exert appetite, that we do undergo answerable motion; and that these conditions follow each other in harmonious sequence. But in the very middle of all a singularly occult quality is left; namely, the thing and quality designated by the natures of the soul and the body.

The above force is proper to the soul, independent of every external principle, and of the body itself; and thus it is the force by which the soul produces in one continued series all perceptions and appetitions. I am still perplexed whether to believe or not, that according to the system, all these things coexist in the soul, and the soul lives in its own self-similar principle from the first moment of its existence to the last, when it is released from the body, and destined to live unfettered and free in its own peculiar state. And whether therefore it pays only by imputation the penalty of the motions performed by, and the deeds done in, the body; which must be the case, if the soul is altogether independent of external principles, and of the body itself. Thus there must be the whole of the body's nature in it, such as it was when it existed. Consequently the soul must be an entity disconnected from causes, and nevertheless natural, and existing in the world. How then can it subsist, or perceive the thoughts of others either mediately or immediately? How can it feel the delights of the world, or of heaven; or in heaven the delights of the assembly of souls, or in the world the delights of congenial society? How can it feel the grace of God applicable to itself? how apply that grace with a sensation of love involving connexion and dependence? And how can moral actions possibly exist, when there can be nothing moral in them, beyond the harmony and concordance of the modes and motions of the body with the perceptions and appetitions of the soul? If souls can be affected neither outwardly or inwardly by their bodies, are then all souls of similar quality? To each of these questions I know not what to say, and I should be in ignorance of all, were I credulously to trust to the dicta of such an authority. The absolute independence of the soul proclaimed by this system, turns rational philosophy upside down, and this independence must either be rejected among occult qualities, or the whole moral world, and all moral actions whatever, together with the dependence of effects on their causes, generally and specifically, must be pronounced occult. If such conclusions as these should pass unquestioned and become ratified; if we believed them written in Jupiter's archives, it would thenceforth be vain and fruitless to spend any pains in the attempt to penetrate into qualities; far better would it have been that all who had hitherto expended the midnight oil in the search of causes, or had exhorted posterity to the effort, had erased their lines and consigned their papers to oblivion.

The soul would represent to itself perceptions and appetitions in the same way that it now does, were there no body, or no visible world in existence. That is to say, its state would be single or unique, and always identical and perfectly similar, both in the body and the world, and out of the body and the world; inasmuch as it would represent to itself its perceptions and appetitions in the same manner in the one case as in the other. I am afraid the proposition also involves, that the soul is neither in the body nor out of the body; neither in the world nor out of the world; or that it is universal, with no special engagement to, or conjunction with, the body; or that it is all one whether it be present or absent; or whether new souls are supernaturally created from day to day, or all souls have existed from all eternity; and that souls subsist in the same supernatural manner in which they existed at first; and consequently that the same must be predicated of a body formed for similar *harmony*. But meanwhile, as in this absolute independence, I can see no connexion, and no cause, and no effect, so I am inclined and obliged to dismiss it too, like the rest, as the substance of a foreign world, among occult qualities.

This force is bound to observe certain laws; consequently there are laws of perceptions, as well as of appetitions, and the law of sensations contains the essential determinations of the soul. All the actions of the body furnish signs and proofs by which we know full plainly, that there are laws belonging to the perceptions and appetitions of the soul; and as the soul is self-conscious, and conscious of the actions of the body, we have no need of any extraordinary ability to comprehend these declarations. But the difficulty remains untouched. What is the nature of the laws, which can thus harmonize with those in the body? We are conscious that the soul's force or actuality is subject to laws and rules, within which and to which it is limited; but this being the case, I do not well see what becomes of its representation of the universe. But as nothing can be plainer than that force, perception and appetition really exist; likewise sensation, essence and determination, all having their laws; so in the foregoing statement we are raised not one jot beyond common experience; for the knowledge of which we have no occasion to consult any oracular system. And we may remark, that the soul's rationality does not consist in the consciousness and perception of the actions of the body or the individual, but in the mind's power to form conclusions therefrom by a chain of reasoning, and wisely to educe the very quantities and qualities that are involved in causes. We know indeed that there is no appetition but has a cause, and that every cause must be connected with a prior cause; consequently that there is a connexion of causes, before we desire what we perceive. Rationality therefore does not consist merely in knowing that we perceive and desire, but in the ability to trace the connexion of causes, and to conclude thereby what ought to be desired, and carried over into the will, and by its instrumentality into action and effect. The effect or fact of rationality perishes in the first instance, when having contracted habits by long custom and frequent indulgence, without any examination of causes, we no sooner perceive than we desire, no sooner desire than we will, and no sooner will than we commit to action; when appetite treads on the heels of perception, and will is simultaneous with appetite; and the volition with the effect: and so forth.

There is a law of imagination which must have some share in the law of sensation, and vice versâ. On this shewing, imagination would depend by its laws upon sensation; but this relation, so far as it involves any communication, is incompatible with a state in which each is independent of the other; inasmuch as ideas and images are as they are termed material, and the immediate property of the organs, and the organs belong to the body; and inasmuch as the before-mentioned ideas are harmonic with perceptions, as are the motions of the body with appetitions.

God has preëstablished a harmony between the soul and the body; insomuch that he has adjoined to the soul a body capable of undergoing series of motions agreeing with the perceptions and appetitions of the soul. We are all aware that there is a harmony between the body and the soul, and that the actions of the former follow connectedly from the perception and will of the latter. The mind, however, longs to examine the connexion or intercourse, and unwilling to rest in this lowest knowledge, or to submit to the dictatorship of the senses, requests the system to point out, or to shew the possibility of pointing out, the actual nature and quality of the above harmony, and of the intercourse also. The existence of the harmony and intercourse is undisputed; what is desired is, to have the opinion of the wise respecting the quality of the same. It is not questioned that the eye sees; but the point is, how does it see, and what are its forces and laws, and the modification and combination of the rays as they pass through the various structures of the organ? Again every one knows that the ear hears; but how, and by what instruments and means, the modulation of the air constituting sound is apprehended by that organ,—this is the matter requiring explanation. The harmonies of tone and tune are in our most common and public knowledge; but the nature of the harmonic laws and ratios, and the causes of the same,—these are pursuits worthy of experiment and understanding. Thus what we want in the system, is a precise account of the quality of harmony, and the interpretation of points that are at present obscure. To this our sapient author replies, that harmony exists, that there is such a thing, and that God has preëstablished it between the soul and the body. In this way he dams the stream and prevents the issuing waters, and puts out and kills in a moment all desire and hope of knowledge, declaring that harmony is preëstablished, or what is the same thing, that the preëstablishment is an occult quality. If Themis had given it as an oracle that the primordial substances of the world were atoms, and that in these atoms there were an essence and forces whose laws were occult, and yet that there was a preëstablished harmony between the atoms and the compound substances of the world, would not later ages which were attempting to penetrate into the qualities of things, hand over the whole story to their comedians, as an amusing record, fit only to be put upon the stage? or resign it to other artificers, as the worn and useless body of Æson was given up to Medea for renovation? The cultivators of this system terminate all knowledge of our microcosm in their harmony, and encircle wisdom with a fence, to prevent any one from looking for the qualities of the soul, which cannot fail, like the harmony itself, to be preëstablished and occult. And if haply any be unwilling to stand as perpetual doorkeepers before the threshold, and should knock at the door, or dare to enter the house, there is no lack of haughty warders to order them away from the sacred premises, and to command them to betake their profane feet in another direction. But as the existence and the possibility of harmony are current pieces of knowledge, the system proceeds to tell us, that God has joined a body to the soul, and in the former therefore there must exist a consent of motions with the perceptions and appetitions of the latter. Nor can this be other than true, for every self-conscious being knows that the body does and effects what the soul desires and requires; and that actions and effects harmonize and conspire with their proper means and causes. However, the independence mentioned above, distracts the mind, and causes it to doubt, whether a harmony such as this can be assumed, implying concord during every moment and in every mode between two subjects and substances, without a connexion and dependence; except only with regard to the specification of perceptions, and the continuity of the time in which they happen, together with the changes in the sensory organs. And as there are the most constant laws in the soul, and a single simple force that produces and represents all things, and likewise a constant harmony, constant because preëstablished by the Deity, so I do not see how in this case these can unite in a third term, and how the mind can thoroughly conspire with the body in unharmonious and discordant actions, totally at variance with the moral world; and this, so completely, as to feel unharmonious things as in consonance with it, and to desire them, keenly pursue them, and make them grounds of action. And unless the Almighty had given the mind a body answering to the harmony, or to the soul, how could the one coöperate with the other? Should we not otherwise have a harmony without harmony, a discordant concord, the soul being permanent in its state, obeying and willing to obey no other laws but its own: unless we suppose in the soul none but a force to the last degree passive, in which all things in the universe can be represented; and no active force to produce and represent, by its intrinsic means, the sensual ideas, and perceptions or appetitions, of which we become conscious by motions in the body, or by modes and mutations in the sensory organs. Hence in this way these also are precipitated into the same lake of ignorance and oblivion, into the same occult quality, with the harmony itself.

God has not preëstablished any appetitions in the soul, but only a harmony between the motions excited in the body by the impressions made upon the sensory organs, and the perceptions of the soul; or between the voluntary motions in the body, and the appetitions of the soul: this however apart from any real dependence of the soul upon the body. I shall not here entertain the question, how far these propositions are consistent with the foregoing, or with the system of preëstablishment; but shall content myself with denoting the number of unknown qualities involved in the above statement; the number of qualities destined to be for ever unknown, according to the dictation of this imposing system. Meantime, however, the conclusion is given, that there are perceptions in the soul, but that it has no preëstablished appetitions, there being in it therefore something not preëstablished, although it is a simple, single force that produces; and nevertheless, that this something is of the mind or in the soul. I do not see where appetition comes from unless there be a previous perception; or will, unless there be an antecedent appetition; or these things at all, unless there be a previous force. If then there be a harmony between the modes in the sensory organs, and the resulting motions in the body and appetitions in the soul, it will follow that the soul does not exercise appetency or volition *per se*, but by the instrumentality of the organs, and if left to itself would have no determination or will, or would appetize or will all things universally, and direct choice and will to all things, *i.e.*, to nothing in particular. At this rate I cannot comprehend what there is in us that can desire and wish for moral good, or that can disagree and combat with the body; I do not see what there is that can desire heaven, or the favor of God; or that can feel love, or endeavor for, or aspire to, wisdom; what there is to give life to perception, or to feel delight in it; &c., &c. All these points will be obscure to me, so long as I do not know whether appetitions differ from harmony in not being preëstablished, but originate from impressions made upon the senses; and so long as there is thought to be a harmony preëstablished by Deity between all the motions of the body, and the corresponding appetitions, whatever their nature be, in the soul: also so long as I am in doubt, whether there can possibly be harmonies in two subjects that actually are consentaneous with each other during every moment and in every mode, apart from any real interdependence. It requires a soothsayer to reconcile and explain these occult qualities.

The material ideas to which sensual ideas correspond, depend upon the impressions made by sensible objects upon the sensory organs: and the voluntary motions that correspond to the appetitions of the soul, depend upon the motions of the nervous fluid circulating in the motory nerves. These will be among the principal subjects to be discussed in my Transactions, and therefore I shall not dwell upon them at present. *By virtue of the mechanism of the body there arise from the material ideas of sensible objects, motions answering to the volitions and appetitions of the soul; apart from any immediate extrinsic determination.* This also will be considered when we treat of the mechanism of the body and the corporeal motions.

Consequently from the series of motions in the body, a reason may be given for the origin of the perceptions and appetitions in the soul, and for the peculiar nature and quality of such perceptions and appetitions; and vice versâ. *The presence of material ideas in the brain contributes in no respect whatever to produce them.* I should be inclined to believe that from the series of motions in the body, a reason might be given why such or such perceptions arise in the soul, unless I were also told to think, that the presence of the ideas of the sensory organs contributes absolutely nothing to produce them: in which case what the one view joins, the other seems to separate. Where the reason to be rendered can possibly be, I know not, since the presence of the said ideas contributes in no way to produce the above perceptions and appetitions. The predicate seems to involve a contradiction; especially if there be the independence before spoken of, and if the soul and the body verily do not act upon each other by any connexion either of contiguity or continuity; and nevertheless, according to what we said before, the law of imagination must have some share in the law of sensation. Suppose the reason and share to be, that there are similar laws and series of perceptions and appetitions in the soul, as of motions in the organs and the body. What then is the reason, unless there be a connexion and real dependence and consequent consent, that the one acts simultaneously and instantly when the other does? And unless there be a connexion, and the one really disposes the other to act like itself at its intimation and will, what is the reason that we desire to day what yesterday we loathed? Unless there be a real dependence and connexion, what is the reason that the will precedes and enjoins the motions of the body; likewise that the soul obeys the motions of the body, at the very time that it perceives the contrary to be right? And unless there be a connexion and mutual action of the soul and the body, what is the reason that the perceptions and appetitions and corresponding motions are never exactly identical or similar in any two living subjects? And what is the reason, unless there be a connexion, and each affects each, that the frequent recurrence and performance of actions, causes the soul to contract a habit and as it were an instinct of perceiving, desiring and willing, and unconsciously and spontaneously to repeat previous motions? Where but in connexion shall we look for the reason of the amazing correspondence of both the soul and the body in causes and effects? What means the harmony of the two, if the one lives independent of the other? Whence their concord and consent? It must be a sharp eye, such as could see affections in vacancy and nothingness, that discerns the presence of causes and effects, simultaneously with this independence: I freely confess I cannot even conceive such acuteness.

Moreover, *all these predicaments may be understood, without supposing the soul to exert any action on the body: nay, they all happen naturally; and even the fact of mutual intercourse may be intelligibly explained by the very nature of the soul and of the body.* It is at any rate beyond my comprehension, if no action or reaction of the soul upon the body be taken for granted, in what words these matters are to be explained, or how they are to be understood. If it is to be made intelligible by the nature of the two, that nature must at least be previously defined. And if it be defined as constituting in the soul a motive force, simple, single, peculiar, and representative of the universe, still the nature and the force are but one of the occult qualities already named. And I do not well see what can be the nature of one force, one limit and one end, and of no parts, in a perfectly simple being, which exists and subsists from nothing, in its own principle, and separate from the world. If the nature of the motions in the body be the sum, aggregate or product of many motive forces, or consist in a series of modes, or in modifications, still I do not see how on these principles, granting our system, the commerce between the soul and body is brought home to the understanding. The mere words nature, forces, modifications, contribute nothing to this end. Others then must exercise their subtler faculties on these points; to me they amount to an absolutely occult quality.

Nevertheless the necessity of the motions that correspond in the body to the appetitions of the soul, does not deprive the soul of liberty. As this subject requires a peculiarly deep consideration, I intend to treat it separately in one of my Transactions. *Lastly, the mechanism of the body is incomprehensible, though still a subject for probable arguments.* This is the aim of the system, to make all motions, forces, determinations, laws and series, incomprehensible, and yet conjectural; consequently to resolve all their predicates into occult qualities; for it is not considered sufficient to term them natural. What service then has been done by, and what issue is involved in, this far-famed system, further than to make us ignorant of all the laws of our human kingdom, and content with the bare knowledge of their existence? What other service than so to guard the code of the statutes and laws of nature, that it shall be kept shut for ever; and to inflict the punishment of Tantalus upon whoever would dare to force its clasps, or to break the chain which binds it? Such is the watchful vigilance of this boasted system!

If I am not mistaken there is ground to suppose, that *the principles of this system are taken from the method of fluxions or infinites, in fact, from the differential and integral calculus;* in which the differences equal nothing, while both the constant and the variable integrals denote the motion, times, dimensions, lines, areas or bodies. And as there is no comparison between the indefinitely small and the integer, inasmuch as the one is as nothing, and the other is a quantity or a quality, so a harmony is supposed between them, and the same ratio of laws in the soul as in the body; just as in the above analysis, the same mutual ratio of the differences as of the integers, which may be conjoined by analogies and harmonies, and the one be multiplied by the other, although there is no dependence of the one upon the other. Consequently there can be no ratio given between the differential and the integral, and so they may enter into the same equation and analysis; and thus we may elicit from the one what there is in the other, or what is the value of the other. But the arguing from a pure calculus and analysis to real beings, is not valid.

To avoid however the appearance of intending to derogate utterly from the credit and authority of principles which are the mental offspring of the most refined brains and judgments, and which are received by the world as oracular dicta with respectful homage little short of worship; to avoid this, *it is incumbent upon me, myself to propound principles of greater truth.* For no one ought to occupy the bench, or to give sentence therefrom, unless he be really learned in the law, and able, by his knowledge, to settle the cause. It will therefore be my task, in the Transactions which are to follow, to shew the nature of the harmony subsisting in the animal microcosm, and of its forces, laws, series and motions. Of the merits of what I shall advance, let the reader be the judge.

But as I have accused the above system, (in which so many, and indeed nearly all qualities are preëstablished and incomprehensible,) of leading direct to ignorance of creation, so *it is necessary to bring to the bar some general action or effect of the body and the soul, and to examine it by the principles of this system;* in order that we may see and know with clearness, whether by following the rules systematically laid down, we are led to a knowledge of its causes, or whether on the other hand we are led away from light and knowledge to darkness and ignorance. The truth comes out in examples. Now in the whole range of the animal kingdom there is no more usual or familiar affection, than the desire for sexual intercourse, commonly called love, and if legitimate, connubial love. The question shall be, from what natural principle and cause does this affection arise? from what is it derived? If we are to abide in the above principles, we shall probably answer by system, that it arises from a force of appetition in the soul, to which corresponds a similar motion in the body, agreeably to laws, which are natural, and to a harmony, which is preëstablished between the soul and the body. Or what amounts to the same thing, from an occult force of appetition, to which corresponds a similar but incomprehensible motion in the body, agreeably to occult laws, and to a harmony occult to us: consequence love is an instinct, whose effect we experience, but of the subordination of its causes from first to last, we are ignorant. The further question may be put, what are the causes that it actually exists from, and what the means by which it is derived into the body, and passes into effect? It will probably be answered, by material ideas, to which correspond sensual ideas, and which depend on the impressions made by sensible objects on the sensory organs; and that thus arise motions that correspond to the appetitions of the soul, and to the motions of the nervous fluid circulating in the motory nerves; but apart from any real dependence of the appetitions in the soul upon the motions in the body, except that the two harmonically correspond to each other. Still this other question arises, where does this instinct come from, to pass from perception into appetition, and so forth. The reply is, that by the proper and occult force of the soul, it comes into perception; from perception by occult ways and means into appetition; from appetition by an occult law into volition, which may comprehend occult series whereby it is produced; and therefore that to this volition, by an occult and preëstablished harmony, correspond occult series of motions in the body; motions which are incomprehensible, and arise, according to the occult nature of the body and the soul, from the occult forces of the body. Thus whithersoever we direct our steps, we are brought to a stop in algebraic words and symbols, which have no meaning, because they are the marks of occult quality, and which no wise man can heed. For what are force, ratio, law, series, or harmony of motion, without the knowledge of quality, but hollow sounds, of which we must gain the signification elsewhere from qualities of the same denomination: but whether and how they are suitable here, cannot be very evident, since the forces, motions, laws and series in the body are incomprehensible. And still more incomprehensible must be those similar series, &c., that harmoniously correspond to the former, and exist in the soul, in a force representative of the universe, and impenetrable to the understanding; since this force is the property of the soul independently of all extrinsic means, and the soul has these qualities supernaturally impressed upon it, inasmuch as it is a pure substance, made out of nothing.

But as all the above responses of the oracle involve an immediate refuge in systematic ignorance, it is impossible to ascertain either the point, importance, merit, or trustworthiness of the principles, or to know whether thousands of the like might not be raised up, by giving the soul room and opportunity to indulge its powers of fiction, on the delectable materials of its own ideas. And if faith and authority attach themselves to matters that are, and are to remain, unknown, such matters are straightway accepted as prophecies, oracles, and Sybil's leaves, and often exercise greater sway than plain proofs and facts, simply because no one has power or boldness enough to dispute them. For if the mind be not furnished with any power of reasoning by the series and connexion of causes, or with any great amount of rational philosophy, these principles of ignorance lead it into sure captivity. In this state of things it would be vain to hope to see a rational psychology publicly established, or to attempt to bring out causes that lie hidden in the bosom of nature, from the numerous data and really exquisite experiments which the scientific world possesses at the present hour.

What would the ancients feel, could they rise from their graves, and revisit the learned world, *when they heard that they had lost their cause,* and that the moderns had pronounced in favor of a preëstablished harmony; in favor of substance attaching to nothingness; of force implanted and independent, and nevertheless coöperant; of the existence of qualities really similar to geometrical qualities in non-extended things; in favor of fictitious infinities in non-immaterials; of an empty universe, with bodies floating in it geometrically and mechanically by their own and implanted laws; in favor of the necessary occultness of the whole sphere of invisibles? Would not their anger be kindled against our schools, and would they not demand of us, by the laws of nature and reason, why we have thrown away their monads, to substitute a number of equally occult things.

They must indeed wonder, could they reappear upon the scene, or live over again in our times, that our age should be notable in great attempts, so remarkable for facts, that it can boast that the measures and modes of nature are all ascertained, and that nature herself, with her mysteries and secrets, is wholly in possession of the learned world; and yet that beyond her face and clothing nothing is known, but she lies in the bosom of her causes, more deeply out of sight than when she quite hid her countenance from an inexperienced age.

Meanwhile it must be confessed, that our contemporaries have spared no means, and omitted no opportunity, to elicit the forces and causes of nature by actual experiment from the world and from phenomena; also that the way of experiment exclusively has been chosen, precisely *that in these respects we may exceed the desert of the ancients.* The ancients indeed came to a stand-still at the very threshold of the heavens; but modern astronomers, with their feet upon the earth, have surveyed with curious gaze the inner chambers of the sky; with telescopic vision have penetrated the secrets of the moon and the wandering stars, and recognized the valleys and mountains diversifying their surfaces with light and shade; also have visited the satellites and moons of the planets, and numbered the spots on the sun; and lastly by the exercise of the understanding, have traced in clear thought the diurnal rotation of the earth upon its axis, and its annual revolution round the sun; and have discovered that the sun himself is stationary, contrary to the apparent shewing of experience, and to the opinion of the vulgar, who still assert the daily revolution round the earth of the whole starry heavens, as reposing on the credibility and dictate of the senses. Thus at the present day, as the poet sings, all the gates of heaven's golden halls are opened:

> Reseratis aurea valvis atria tota patent:

and we are at home in that Olympus in which, to continue the comparison, the ancients were but strangers and sojourners. In this respect,—in the search and evolution of this deeper order of the mundane system,—how vast have been the services of our contemporaries,—of Copernicus, Kepler, Galileo, Tycho Brahe, De la Hire, Flamsted, Hevelius, and many more, all deserving to be raised to their own province of the skies with threefold honors and commendations, and as they have eclipsed the achievements, so to make dim the praise and outwear the renown of the ancients. And had these enquirers preceded the days of old astronomy, then had the ancients themselves sacrificed to their shades, and paid them the honors due from whoever was their posterity. Or note again the preëminence to which the talent of the present age has advanced the science of *geometry* and analysis—of geometry with its measures and analysis with its ratios; observe how nearly it has reached that pinnacle beyond which it can scarcely hope to rise: and how from that loftiest elevation it looks down with comprehensive thought on the far-stretching plains and countries at its feet, and above all on those three mighty and most ample kingdoms, the mineral, the vegetable, and the animal, which it longs to visit, and to exercise its art and science in their fields. Nay, to geometry no object is more priceless or desired, than the permission to be present in the secret councils of the queen and empress of those kingdoms, no other than nature herself, ever true to her own principles, of measure and harmonious modulation. For to the geometrical art and mind it belongs, to find the true result of proportions, numbers and symbols, and to bring forces and laws themselves to the bar of calculation;—to that calculus which it ever has ready to apply; and by means of which, as the poet says, it can split the least of coins, through a long series of ratios, into a hundred parts. If Archimedes, the unquestioned prince of Greek mathematicians, and the boast of his age and country; if Euclid, the most eminent geometer for many ages in the fertility of his resources and the keenness of his judgment, and who owed his greatness to his own unborrowed powers, and founded so illustrious a lineage of disciples; if these great men were now alive, with what earnest affection and delight would they regard the present century, and the geometers of this favored period; especially Leibnitz, crowned with the wreath of fame by his own compatriots; and Newton, towering above his countrymen, and conspicuous with the badges and reward of acknowledged and triumphant genius; also the brothers Bernouilli, and other successful mathematicians, who have either built up the analysis of infinites or fluxions, or have applied it with admirable skill to the art handed down from Euclid and Archimedes; thereby constituting a science of which the ancients afforded only a mere foretaste and slender fruits. In geometry, then, the ancient equally with the modern world deserves our praise; aye! and the one as well as the other aims to eternize the written labors of its chosen sons by its own peculiar memorials. It would occupy many pages were we to specify all the arts and sciences that our age has advanced to almost a prerogative degree of excellence; whether we regard those branches of knowledge which we have resuscitated and improved from the remains of ancient learning, or those conceived by modern genius, and brought into clear light by the modern understanding. But among the most memorable of these acquisitions we may mention those inventions of optics, which have taught us in this late age to sharpen our vision, till now we can penetrate to forms and images that lie hidden in a world purer than our eyesight can attain; and have given us a more discriminating light than hitherto for exploring the minimal fields of nature; in short, have made objects nearer and more present to us, and diminished the impediments of space. Thus we can now make lenses and glasses, and duly polish them; we can construct microscopes and telescopes, whereby the eye can bend its keen vision upon the minutest animalcules, and fixedly contemplate them; although such animalcules were formerly less than the simplest ray of that organ; and so by these appliances, there are innumerable things in the light of our day which entered into nothing but darkness with the ancients. And now we can measure with scientific glance in different parts of the vortex of our sky, the bodies that wander around the sun, and prove to be earths like our own; as well as the moons, in ancient times unseen, which accompany them in their course. But to detail all our riches in this kind would exceed my space. Suffice it to say, that the preëminence of our age in these respects, is due not only to the English, but to the French, Germans and Italians, all which nations have given birth to great inventors and improvers of the methods of art and science, who are too firmly seated in their high position to need any praise of mine. Our contemporaries moreover have vindicated rational philosophy from its long grovelling among the trivial questions and learned dust of the schools, and have brought it forth on a new ground, to enjoy better opportunities and nobler objects. As the laurelled victor in this achievement we must mention the name of CHRISTIAN WOLFF, the greatest philosopher of our epoch, who disdaining the empty honors and fame that are gathered behind the shield of some illustrious leader, disdaining to wear the mere skin of the lion, has won his success with his own arm, and defends it by his own original prowess.

It now remains for us to close with nature where she lies hidden in her invisible and purer world, and no longer barely to celebrate her mystic rites, but to invite her in person to our chamber; to lay aside the few draperies that remain, and give all her beauty to our gaze. *Rational philosophy* has already given us precise information respecting her forces, causes, modes, reasons, laws, series, connexions, and so forth. *Geometry* with *analysis* has enabled us to contemplate her numbers, measures, degrees, moments, figures and dimensions. *Optics* has instructed us of her form, countenance and apparelling within the sphere of those rays that are less than the organism of our sight. *Physics, chemistry,* and *experimental psychology* have delivered her motions, actions and effects, as well in the elemental world of the atmospheres, as in the three kingdoms of the same world. It is now beyond her power to avoid the acumen of the learned, or to hide herself any longer in occult qualities, and suddenly to elude us. Almost her last garment is put aside, her last veil deposited; and she now demands of the present century some man of genius—his mind developed and corrected by experience, prepared by scientific and other culture, and possessing in an eminent degree the faculty of investigating causes, of reasoning connectedly, and of concluding definitely on the principles of series;—and when such an one comes, to him, I doubt not, she will betroth herself; and in favor of him will yield to the arrows of love, will own his alliance and partake his bed. Oh! that it were my happy office, to fling nuts to the crowd and head the torch-bearers on her marriage day!

§ 3.

The mind does not receive it for certain that the soul is a purely simple substance, unless it knows precisely what kind of simple substance. Having banished the atoms of the ancient philosophers from the stage of the learned world, (in fact, these atoms have died of mere old age, or only survive in the historical records of philosophy,) the moderns have adopted instead a theory of monads and simples as the primordial substances of the world. So fashionable has this become, that we hear of nothing from the pulpit and the professorial chair but mere simples, which are received with unanimous delight by applauding audiences. But were I to add my voice to the throng, I scarcely think that I should swell the estimation in which these favored entities are held; at any rate, so long as I am in ignorance of their nature and qualities, I should but contribute with the rest another element to a senseless sound.

And we are indeed confounded with the variety of monads and simples, of which a number is fabricated equal to meet the case of all the essences and substances purer than the organism of our senses. As soon as ever we are required to pass from the effect to the cause, we at once beat a retreat to the asylum of simple substances; and there we concentrate nearly all the qualities that we can possibly recognize in the effect. Rational souls are held to be simple substances, but in order that their peculiar attributes, essentials and qualities may be admitted, the simplists affirm that these substances are gifted with understanding and will. The souls of brutes are also regarded as simple substances, involving indeed an analogue of reason, but destitute of understanding and free will. Spirits also, no matter how numerous or how diverse, are all referred to the class of simple substances. The elements of the mundane system, and the primordial substances of the first creation, are also pronounced to be simple substances, to which the philosophers attach their peculiar attributes and essentials, which must continue the same while modes vary in succession; consequently they are regarded as persistent and capable of modification, or the subjects of intrinsic determinations, constant and variable. In a word, wherever series of things are observed in the world, there do these philosophers come before us with their simple substances, in which, as the principles of the former, we are desired to conceive an analogue of similar series. To every such substance in general and in particular they attribute efforts, forces, determinations, laws, series; or what amounts to the same thing, a certain proportional or analogue of the said qualities; with other predicates, which we must conceive and represent to ourselves abstractedly, purely, analytically, by the bare faculty of understanding and imagination. They assert that all entities and substances of the kind are begotten and produced from the same origin; viz., all from nothing; and nevertheless that there are affections in them, which affections are not of nothing, but suitable qualities of every essence whatever. Moreover, in these simples there are no parts, hence no limits separating parts, but within them all is pure, mere essences with their proper forces, efforts and determinations, which nevertheless again are limited and finite, because natural, and subject to the restraint of their own distinctive laws: they are indivisible into points or parts, because intrinsically devoid of points or parts; but if divided, they would relapse into their pristine nothingness; furthermore, they are destititute of the degrees or quantities of quality, as well as of moments; or of dimension, measure, &c. * * * * *

[Here thirty-two pages of the MS. are wanting.]

* * * * most averse to the truth; and this is the reason why rational philosophy is so often the source of errors, and why its most celebrated cultivators stray more widely from the right path than those who place their ultimate causes in mere causates. When reason abides in causes, at so great a remove from effects, it frequently inculcates upon the soul, with a power amounting to command, a belief in certain effects or consequences equal to the belief in the causes: as is the wont with systems of all kinds. But this by the way.

Meanwhile, in prosecuting the physiological argument we have no right at the very outset restlessly to enquire into the substance of the soul, with its proper forces and laws, that is to say, into the causes of effects, and at once to prophecy that the soul is generated immediately out of nothing, and is simpler than aught in nature; and thereupon to reason to the effects by a neat apparatus of consequences. To arrive in this wise at the truth of consequences would indeed suppose nothing short of a divine understanding. Once possessed of this, the dark seeress, mindless of her tortuous riddles, shall utter the sayings of the time to come with prophetic certainty. But dismissing recondite principles, let us confine ourselves to enquiring, whether we are to regard the soul as in the world, or within the circle of nature, contrary to the opinion of our contemporaries, and to some of the lights of modern philosophy, who turn the soul out of the world, and give forth that it would be all the same if there were no world and no nature in existence. As soon as we have established that the soul is within the circle of nature, or belongs as an entity to the purest sphere of the sky, we may then proceed under the direction of philosophy to enquire into the nature of its motive causes, powers, laws, series and substances; likewise into the connexion, relationship, and familiar bond that it establishes between itself and the organs of inferior rank, namely, the series constituting its body, and which it has evidently taken into the most close amity and kindredship. That the soul has the sceptre, and occupies the imperial throne, of the microcosm, she herself declares to us; likewise that she orders the fortunes and provides for the welfare of her body; and that her influence is paramount in works and actions, whether coming from the will, or whether derived from instinct without any appearance of an antecedent exercise of choice.

Now that the soul is really in the world, and within the circle of nature, is plain from the fact that the soul is in the bodily microcosm. But those who class it among the entities of no world, and would drive it, if they could, not only out of the world but out of its own kingdom,—they, we repeat, have the soul nowhere. Again, that *the soul is enclosed in the walls and limits of its kingdom in the body*, is manifest from this, that from the very earliest moment of embryonic formation, it begins to preside over the diminutive frame, and takes into its own hands the power over all parts and over all relations, in the womb, in the cradle, in the germ of fœtal existence, in the dawn of tenderest infancy. Without an instant's delay it assumes the helm, and sits in the steersman's place, and by the guiding needle of its own nature shapes the whole course of the advancing vessel. Aye! no sooner does its activity begin, than with the first thread that is woven, it publicly constitutes itself the cause, the prince, the arbiter, and forms its own order of government, and guards as its own with watchful care the effects in the body; in the first instance those that come by nature, and afterwards as the state increases and the body grows up, it brings the affections of the body within the sphere of its reason. That the soul does attend to the affairs of the microcosm, and does promote its welfare,—this we know by our very senses, which borrow from it as the real agent and doer, that is to say, from its desires and decisions, the principle and the power of all their modes or mutations. Thus our consciousness of effects proclaims, that the soul is appointed over the body, and associated with the body; in other words, is enclosed in the brains, and engirded or enveloped by the skull. That it is the close companion of its body, and follows the traveller from place to place even to the ends of the earth—*si vel Indos petas vel Bactros*—that it sails with the navigator from every port, in all his voyages over the trackless ocean, nor ever deserts its peculiar kingdom and native country; this may be concluded abundantly from every effect, action, sense, desire, and from the power, determination and manner of its will. Wheresoever thou art, there thy soul is with thee, entering into all thy works. Thy soul is conscious of all thy movements. Thy soul is not another's, but distinctly thine. Whatever is thine is thy soul's also. Whatever is thy soul's, is thy body's, and thine. Whatever is predicated of thee, is predicated of one unanimous subject, or conjointly of the soul and the body. The cause and the causate, the efficient and the effect, endeavor and motion, will and action, the first term of the series and the last—all stand for one cause. The whole microcosm is one series, although it consists of numberless connected parts, all different, but all unanimous. Such being the closeness of connexion, therefore all the parts breathe a common purpose, and live together in series and combination; every part being sentient, for not a membrane, so long as it is connected with the system, can be touched without sensation. If the general weal suffer any violence or convulsion, or if any part fall into incompetency or decay, the soul feels the evil at once with deep grief and pain, and lends all the succour that it possibly can, to save the fortunes of the endangered and falling republic in whose councils it sways. In a word, so great and binding is their friendship, that so long as the soul and the body live, there is no possession belonging to the parts but belongs to the whole. That soul then that thou carriest with thee whithersoever thou goest, is enclosed in space and in its own world; yet still abides in the highest place, in its own senatorial hall. The corollary is, that the body lives in dependence on its soul, and the soul in dependence on its body; also that the soul is no purely simple substance; no imaginary being, of which neither place, nor connexion in any sense, nor extension can be predicated; and it also follows that the existence of the world and the body are *not* indifferent to the soul.*

That the soul is within the circle of nature, and is in the world, and in the human body, and therefore in place or space,† is rendered additionally evident from the consideration, that the soul cannot be released from the ties of its body, by anything short of the utter death of the latter, which alone is sufficient to break the chain and detach the strong connexion. As soon as the day arrives which is fatal to the body, the soul eludes the chains and flies out of the prison of its habitation; and then straightway the nerves and the tendons and ligaments drop down flaccid; the membranes and the cords which gave tone to the system lie loose and purposeless; the powers of the muscles evaporate; all warmth and continuity of tension disappear out of the blood; then too all sensations, which are common to the soul with the body, perish, and the very organs of the senses are yielded a prey to death. Only at this moment it is, when these ties are annulled, that the soul is freed from the prison-house, and retires out of her kingdom. This is a sign, that the soul is inherently tied to its body, and enclosed in the membranous cells and compartments of the latter;[*] which could not be were it a simple substance, for in this case its incarceration would seem to be impossible; and less still could it keep its place in the brain so long as ever it was not stripped of the membranous ties of its body. Therefore the soul awaits the fate of the series that are placed under it to serve it, and when these lose their natural harmony, the body then undergoes the last struggle, it gasps, fails, and gives up the breath of life.

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* Contrary to the doctrine of Leibnitz, and in later times to that of Berkeley, that sensation, perception, and in general, the mental faculties, might be enjoyed, without the presence of an external world, or a material body.—*(Tr.)*

† In asserting that the soul is in nature and in place, Swedenborg implies that it is a part of *creation*—of the finite sphere: he does not mean to deny that it is a part of the spiritual world, but that world, at this period of his life, he regarded as within the circle of nature; *i.e., finite creation*. Nor is he peculiar in this; for before the spiritual world was revealed experimentally, it may be doubted whether the conception existed of a universe altogether beyond nature, yet finitely substantial, and totally external, as that world is, to the human mind and soul. But his argument for the non-simplicity and the intelligible reality of the soul, is not impaired by this necessary shortcoming in his experience.—*(Tr.)*

So when the body has performed its part upon the scene, and the soul has lost the use of the sensations common to itself with the body and its organs, then the soul takes its flight and emigrates from its palace. By no means, however, is it therefore exiled beyond all worlds, or consigned to any place or position either above or below nature; but only entering upon a freer field of existence, it expatiates in the fulfilment of its own nature over the immensity of heaven, and rises higher into the celestial aura, the more purely and holily it has lived in its microcosm, and the more finely it has there been moulded into correspondence with the genuine state of the causes of heaven and the principles of its own particular essence. And still impressed most purely upon its simplest modifiable substances as causes, there remains in it the effigy of the body with its motions and effects, just as the figure of a tree with all its details is involved in the seed. Also at this time whatever actions through the instrumentality of the body have by long usage become habitual or instinctive, are still represented to the life in the separated soul. If therefore the soul be formed in the body, under the gracious providence of God, by the practice of virtue, into a correspondence with the principles of morality in conjunction with religious faith; that is to say, into a correspondence with the supremely constant causes and the original and only truths of heaven, of which the soul in its higher integrity is the adequate recipient; and if the process have been maintained until it has become a habit and almost an instinct, to will and desire nothing but what is in accordance with those genuine and purest causes; then is the soul a true and most fitting subject, organ and instrument of the almost instantaneous and highly harmonic modes of heaven. And thus heaven, which is perpetually receiving life from similar souls, creates by its thorough accordance with them ineffable joys and delights; joys with which those of this gross world admit of no comparison; so slow, impure, mixed, and often so discordant, is the music of our lower sphere. But of this more in another place.

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[*] It must not be supposed that Swedenborg ever modified *this* doctrine in his theological works. On the contrary, he there states it with additional particulars, and gives it an experimental basis. See especially the *Arcana Cœlestia*, vol. i., n. 179, where in describing (from personal experience) the resuscitation of man from the dead, he dwells at some length upon this *enclosure of the soul*, as being so real and complete, that without a special divine attraction, resurrection would be impossible. If that materialism is frightful which gives us nothing but body for a soul, at least equally frightful is that immaterialism, which asserts a soul with no predicates that can bring it under the conditions of human knowledge and experience: which refunds all things into phenomena or states of an occult entity termed *mind*. But the time has come when the fearless acceptance of experience and common sense as the only basis of induction, must uproot from philosophy its *idola theatri*, its materialism and immaterialism, with other poor but pretentious sectarian creations.—*(Tr.)*

It follows from what we have laid down, that the soul is in the world, and by the intervention of nature, is in connexion with the body, and in harmony with its own purest world, namely, heaven; in fact that it is finite, and within the limits of nature,* attached on the one hand to the bodily microcosm, contiguous, on the other, with heaven, and dependent upon the aura of heaven: consequently it is a substance belonging to both the purer and the grosser world; and meant to be conformed by means of the grosser world, while it lives in society with its body, to the state of the purer world. Thus the soul has a place, a time, an origin; also a power and a force of passion and of action.

We are deceived and mocked by our senses and the imperfect sphere in which they live, and our senses by their peculiar atmospheres, which are so remote from the purest atmospheres, that scarcely any comparison can be instituted between the two save by very high proportions and analogies. What is the unit or minimum in the external senses, may be the aggregate, product or maximum in the purer senses and auras. The series of the grosser senses may commence where the series of the purer senses terminate; and the sensation of sight may begin where the soul's sensation ceases. The smallest degrees and moments proper to the organism of sight or hearing, may serve for the greatest in the soul. That is to say, within the minutest moment* of sight or hearing, thousands or myriads of corresponding moments may be formed in the purest organ, of which moments we do not become conscious unless the modifications have products adequate to the modes of the grosser senses, whose moments and times can be observed; all the rest escape our view, as being devoid of time, moments and degrees. We are conscious only of effects composed of an infinity of least effects, and of series existing from manifold causes, or from causes subordinated one to another through many series. And when we are not made conscious of the causes, then we think that they have in them no degrees, or moments, or laws, succession, or series. For this reason it is that we fly to substances defined of nothing,† which substances cannot be anything, because nothing and something are mutually contradictory; or in the words of Christian Wolff, the most illustrious philosopher of our age: "If you set down nothing as a position, you may do so as often as you please, and still it will be nothing, not something." He also says: "The knowledge of empty terms is no knowledge at all; and where nothing cheats us under the guise of a cause, there is no understanding of the reason of anything." And again: "If nothing is assumed, we are not therefore to admit that it is something. If something be assumed to exist, something must also be assumed to enable us to understand why the first something should rather be than not be. Nothing has no sufficient reason why it should be rather than not be." *(Ontologia*, § 61, 64, 70.)

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* If by nature the reader here understands *creation*, he will fall into no error. —*(Tr.)*

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* A *moment* is literally a movement, or any distinct part of a measured series of things; thus in an hour the sixty proximate divisions are termed moments; and any particular detail of a given thing, is a moment of that thing.—(*Tr.*)

† It is remarkable that in our own time more than one system has arisen that has professedly taken *the nothing* for its starting point. There is some candour in this, which of right ought to have been done long ago by many philosophies. Hegel, however, asserts that *nothing* and *being* are identical. Well does Christian Wolff say: "*Nihilum mentitur causam.*"—(*Tr.*)

Meanwhile we can have no better proofs than those supplied by anatomy, to shew that the soul is given and annexed to its body, and is conterminous to the bodily series.* If we elevate the sensation of sight by the microscope, and enlighten the perceptions of the soul with the sciences, we shall plainly see that there is nothing in the body but has a continuous and contiguous connexion; a continuous connexion by membranes of different kinds; a contiguous connexion by the manifold liquids and fluids of the system: and that the one plays the part of agent, efficient and modifier, that is, of principle and cause; the other, the part of patient, effect, principiate or causate. To shew that *nearly all things in the animal body are membranaceous and in this way continuous,* let us begin from the primordial ovum. Now in the female the first ova are enveloped in most pure tunics and matres† of their own; and the testicles as well as the ovaries are constructed by the orderly juxtaposition of membranes. And when the ova are quickened, and the imprisoned embryo is expanded with all the power and form of its father, then the enlarging and thickening tunics become obvious to sight and touch. In this event the embryo is surrounded with the amnion and chorion, and its head with the placenta, whether one or several, and in the case of brute animals, with the farciminal or allantoid membrane also; to say nothing of the twisted umbilical cord. Now these are all mere tunics originating from the ovum, and which are exquisitely tender at first, but gradually thicken and indeed harden as they advance; and they run through these stages in order that the quick elements and atmospheres may form them nicely on the model of their own series, according to the laws of their several pressures, actions and modifications. We need hardly allude to hydatids, which again are skins and bullæ containing serum. In every direction in the series of the body there are scattered glands, which excrete and pour forth liquids, and sharpen and rectify the same, to fit them for adoption into their proper places, and for supplying defects, when the parts in the series, wherever situated, require renewal. The glands are spheroidal forms, enclosed in particular membranes; each being a conglomerate of other smaller and simpler glands, all surrounded by a web and network of membranes, and forming clusters or groups of which the larger gland appears to be made up. Such, for instance, is the case with the pituitary gland in the sella equina, which is enveloped and suspended by the dura mater, attenuated however until it almost looks like the pia mater. But not to specify the several glands, we need only remark, that the purpose of them all is, to secrete menstrua suitable for renovating the several parts of the body, or to filter juices, that will readily and naturally enter into and distend the membranes; and that therefore there are various orders of glands, mucilaginous, lymphatic, salivary, ceruminous, sebaceous, lacrymal, &c., &c., differing in color, shape and use, on account of the very different duties they perform. But respecting the glands we refer the reader to special anatomical treatises on the subject. The substance of the fat secreted from the blood and other liquids, consists entirely of conglobate portions, and each of these, of membranous cells and loculi. So also the marrow of the bones, and its individual parts, which are more minute than those of the common fat. To say nothing of the vessels, vesicles, and different follicles. The muscles consist of fleshy fibres * * * * * *

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* The reader will find the argument on this subject finely handled by Swedenborg in his *Outlines of a Philosophical Argument on the Infinite, and the Final Cause of Creation,* &c., where nearly the whole of the second Chapter is devoted to the question.—*(Tr.)*

† The word *matres* is here used for membranes. In the organic views of Swedenborg, the membranes, and preëminently the skin, which is the *general* and the fulcrum of all the membranes, by their involution constitute the solids of the system; the animal spirit, the *universal* corresponding to the general, constitutes the fluids of the same. Thus the word *matres* suggests the *matter-giving* function of the skin and the membranes.—*(Tr.)*

[The rest of the MS. is lost].

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OUTLINES

OF

A PHILOSOPHICAL ARGUMENT

ON THE

INFINITE,

AND THE FINAL CAUSE OF CREATION;

AND ON THE INTERCOURSE BETWEEN THE SOUL AND THE BODY.

BY

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INTRODUCTORY REMARKS BY THE TRANSLATOR.

THE following Work was originally published by Swedenborg in Latin in 1734, at Dresden and Leipsic,[*] together, as it appears, with the *Opera Philosophica et Mineralia* of which the *Principia* forms the first volume. It seems to have been written after the *Principia*, at least if we may judge from the circumstance of the latter being referred to several times in these *Outlines*. Besides which, the Doctrine of the Soul is carried out in the latter into many more details than in the *Principia*.

In the *Acta Eruditorum* for 1735, pp. 556—559, the present Work is reviewed, but no positive opinion is expressed of its merits, although the critic hints that it has a materialistic tendency.

The *Outlines* was one of the first of the author's philosophical works which excited attention in England, and a translation of it was executed at Manchester, as early as 1795,[†] by two of the scholars of the Rev. W. Cowherd, at his Classical School; but which, as might be expected, was by no means a successful rendering of so difficult a work. There is, however, a brief Advertisement prefixed to the edition, which contains some observations by the Master so just and pertinent, that we need offer no excuse for inserting them here.

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[*] "Emanuel. Swedenborgii Sacræ Regiæ Maj. Svecicæ Collegii Metallici Assessoris Prodromus Philosophiæ Ratiocinantis de Infinito, et Causa Finali Creationis: deque Mechanismo Operationis Animæ et Corporis. Dresdæ et Lipsiæ, sumptibus Friderici Hekelii, Bibliopol. Regii MDCCXXXIV."

[†] "Prodromus, or the Forerunner of a Reasoning Philosophy: concerning the Infinite and the Final Cause of Creation: and concerning the Mechanism of the Soul and Body's Operation. In two parts. Designed principally as an Introduction to the Economy of the Animal Kingdom. Originally printed in Latin, at Dresden and Leipsic, A.D. 1734. By the Hon. E. Swedenborg, S.R.M.S.C.M.A. Manchester, 1795."

"To establish rationally," says he, "on solid grounds, some satisfactory knowledge respecting God, the soul, and eternal life, was indeed, professedly, the primary end, the ultimate scope, of all our author's philosophical disquisitions, as well as theological researches. And, directed towards objects in themselves so interesting, he will be found to have selected such means, in the guidance of his laudable pursuits, as necessarily carry him to discoveries and conclusions no less important than convincing. *Facts,* natural and revealed, were alone what he either could, or did, rely upon with security. From *visible* effects in nature, and in the human body, by retracing all things philosophically to their cause, he was led, and will lead others most fully, to acknowledge that there is a God of infinite love and wisdom, and that man hath an immortal soul. And from the *actual,* though divine and supernatural, manifestations recorded in the Sacred Scripture, he hath been enabled more immediately to ascertain *what* God is, and what the soul, as to form in particular. For do not the Scriptures positively declare, that *God* hath been *manifested* to the patriarchs of old, to Moses and the prophets, and finally to Christians in the person of Jesus Christ, ever in *Human Form?* And doth not John the Revelator say expressly, that when he was in spirit abstracted into heaven, he could equally as in the body, hear, see, converse, walk, and, in short, live and act as a man; and that he saw there, *as men,* 'the *souls* of them that were slain for the Word of God, and for the testimony which they held?'

"Let not those, therefore, who can accompany our author with pleasure in his philosophical excursions through the shady walks of inferior nature, neglect to rise with him, in the way to their highest edification and improvement, into that superior light which beams effulgent from the Word of God. Neither let such as have already read and received his Theological Works, look down upon his Philosophy as to them unnecessary, or comparatively below their notice; for without a rational idea of the soul, as scientifically given in his Philosophical Works, it may be doubted whether his scriptural doctrines, which apply so immediately to the spirit of man, can be rightly apprehended and fully understood."

The above particulars, we believe, nearly complete what can be said at present of the literary history of the *Outlines.*

The present work may be regarded as in some measure intermediate between the *Principia* and the *Economy of the Animal Kingdom*, which latter did not appear until seven years later. The reader of the *Outlines* will find himself continually in want of some sketch of the views of the *Principia*, and we shall therefore here transcribe from that work the author's own statement of his doctrine of the *simple*, and of *actives*, *finites* and *elements*. The following is from the Rev. Augustus Clissold's translation, Vol. II, pp. xciii—xcix, Preface.

"I am apprehensive lest, at the very outset of our philosophy, particularly its First Part, my readers should be deterred from proceeding further, when they meet with views which cannot but appear strange and foreign to those which are generally received; as also with such unusual phraseology as that of a *Finite*, an *Active*, an *Elementary*, &c.; terms which are unknown in any of our philosophical treatises; that is, which are not applied to the principles of mechanism, geometry, and the elementary world. For this reason it will be requisite, by way of preface, to present a general outline of our work, and thus a key to its contents.

"Every one from the light of reason may perceive, that nature, conforming to principles of geometry, is ever pursuing a most simple course; a course proper to herself, and truly mechanical. He may likewise perceive, that all things in the world originate from what is uncompounded; consequently from one single fountain-head and one primitive cause; that this primitive cause is derived into the various things which are caused (a truth which necessarily follows, if further products are to be derived from those which have already been brought into being); also that no other cause could possibly have had existence than the one which had proceeded by genealogical descent, as it were, from its first parent or simple. This cause, therefore, must be latent in the first simple; and into the first ens derived from it, or into the first finite there must be derived a similar cause. Now since the world deduces its origin and subsequent increments, by a connected and contiguous series, from the first or single end through intermediates to another end; and since there must be present a cause, and indeed an efficient and active cause, before anything can be produced in a series; it follows that there must be a passive, an active, and as a product from both, a compound, or elementary; if therefore there be anything composite, it must consist of two principles, namely, a passive and an active; without which nature herself would be as it were in a state of celibacy or solitariness, destitute of progeny, without any new efficient, hence without effect, without series, without phenomena; in a word, without worlds. With this view of the subject then, I have endeavored to evince that *in the Finite, which is the first in successive derivation from the Simple, is contained each principle, both passive and active,* from which, by the accession of a contingent or physical cause, arose the Composite or Elementary; and further, that in every derivative, whether a Finite, Active, or Elementary, there always coexists a similar cause, and consequently a similar faculty of producing an effect, namely, from the one into the other; thus as it were from one power into another, from one degree into another, and so on farther and farther; that in the derivatives therefore there is latent a principle similar to that which exists in the primitives; in composites a principle similar to that which exists in simples; in effects a principle similar to that which exists in causes; consequently also that nature in her various kingdoms, especially the elementary, is in the cause and in the effect simultaneously; so that from well known principles of mechanism, under the guidance of geometry and the faculty of reasoning analytically, we may, from an effect visible and posterior, safely draw our conclusions not only with regard to effects invisible and prior, but with regard to the very entities which are active and passive; nay to the very cause which is latent in all.

"Let us then, in a few words, present the sum and substance of our philosophy; and in so doing begin from the first Simple. 1. We observe, that in a Simple there is an internal state tending to a spiral motion, and consequently that there is in it a like conatus or endeavor to produce it. 2. That in the first Finite thence resulting, there is a spiral motion of the parts. The same obtains in the other elementary Finites, in all which there is thus a like principle. 3. That from this single cause there arises in every Finite a progressive motion of the parts, an axillary motion of the whole, and, provided there be no obstacle, a local motion of the whole. 4. That if there be a local motion, there arises thence an Active, similar to the agent producing it, and differing only in degree and dimension. Hence that we admit of entities only of a threefold degree, namely, Finites, Actives, and those which are compounded of the two, namely, Composites or Elementaries. With respect to Finites we affirm, that one is generated by the other; and that all the Finites of the genus thus arising, have the greatest possible similitude one to the other; and differ only in degree and dimensions. Hence the fifth Finite is similar to the fourth; the fourth to the third; the third to the second; the second to the first; the first to its own proper Simple: so that he who knows the nature of one knows the nature of all. In the same manner we affirm, that Actives have the greatest possible similitude the one to the other; that the fifth, fourth, third, second, and first Active are all of the same nature; differing only in dimension and degree, in the same way as Finites. That Elementaries also are similar one to the other, since they are compounded of the Finite and Active; the Finites occupying the superficies, the Actives occupying the interiors; that hence the first, second, third, fourth, and fifth Element are all similar one to the other; so that he who knows the nature of one knows the nature of all. We affirm, moreover, that in every Finite there are three motions, namely, a Progressive motion of the parts, an Axillary, and a Local motion, provided there be no obstacle; nor am I aware that in these extremely simple entities any other natural motions can be assigned, or, even if they could, that there are any other than such as I have mentioned; or whether granting the motions of these entities, which no rational person would I think deny, that any other could be assigned more convenient to nature. We observe again, that all these motions proceed from one fountain-head, or from one and the same cause, namely, from a spiral motion of the parts. This motion, inasmuch as it is the most highly mechanical, is also the most highly natural; being that in which, as is well known, the whole potency of nature and all mechanical force is inherent; and if it be granted that it is motion which is the cause of things, then no other motion can be admitted, in this case, than such as is most highly mechanical and most highly geometrical; for from its centre to its circumferences in space, a spiral is one perpetual ens, circular in all its dimensions; and as such it cannot possess in itself anything but what is most highly perfect, most highly mechanical and natural in its motion; being both as to the site of its parts and as to its motion most highly geometrical. In a Simple, however, in which there can be nothing substantial to be put in motion, nor any medium in which motion can exist, we must conceive that instead of a mechanical and geometrical motion, such as there is between parts and in a medium, there is as it were a total or pure motion, that is to say, a state and a conatus hence arising from a similar into a similar *quasi* motion; in which is latent the one only cause and primitive force that produced all the entities subsequently existing.

"Inasmuch as in all its kingdoms the visible world is of so diversified an aspect, and consists and subsists in the series of parts successively and simultaneously arising, it cannot possibly have its termination in the same point in which it had its beginning; thus it cannot possibly have its termination in its own first or mediate series or line of progression, or in its first or second part; for were this the case, there would be no series in existence, neither would there be any ends; because there would be no distinctions into intermediates; consequently no element to constitute vortices; none to constitute ether or air; nothing to constitute fire; much less anything to constitute the innumerable parts of the mineral, vegetable, and animal kingdoms; in a word, there would be no world. Hence it is, that my first aim has been to demonstrate, that the first Finite derives its origin from the Simple; the second Finite from the first Finite; the third from the second; the fourth from the third; each being attended by a cause similar to that which exists in the primitive Simple, and which passes, by successive derivation, into the Finites. Hence I shew that a series of Finites thus springs from a Simple, or from the first Finite, in succession to the fifth Finite. These five Finites have a mutual relation to each other, and differ only in degree and dimension, or in their ratio to each other according as they are raised to successively higher powers or degrees. Again; inasmuch as all Finites are capable of becoming Actives, or of performing gyres from a like inhering and concomitant force or cause, that is to say, from a spiral motion of the parts; and inasmuch as they can pass also into a Local motion, provided there be space and nothing in it to present any obstacle; it follows of course, that there may be a fivefold series of Actives; an Active of the first, second, third, fourth, and fifth Finite points respectively; and hence that by means of the last or fifth Active, the fire of our system may pass into our atmosphere. The same law obtains in regard to the compounds or Elementary particles; which I hold to consist of two principles, namely, Actives and Finites; the Finites occupying the surface, the Actives occupying the interiors. And inasmuch as there is thus a series of Finites and of Actives, there will also be a series of Elements such as the first or most universal Element, the second or Magnetic or vortical Element, the third or Ethereal Element, the fourth or Aërial Element; before the elementary kingdom belonging to the world has yet been fully completed. And since every single particle of each Element is elastic, encloses Actives, and possesses the faculty [*vi*] of passivity and activity; hence the first Element encloses within it the Actives of the first Finite; the second, the Actives both of the first and second; the third, the first Elementary particles; the fourth, both the first and second Elementary particles; the two latter Elements participating in each principle, although they enclose not real Actives but Elementary particles. For the Elementary particles are not only passive but active; they are consequently elastic, and are moveable in particles and volumes; the motion and mechanism of their volume depending upon the motion and mechanism of their particles; although they are not mobile and elastic in the same degree as the enclosed first and second Elementary particles from which they receive their elasticity. Thus we shew that the Elements also differ in degrees and dimension, progressing equally with the Finites, &c., in a certain order and succession.

"The series of these several subjects will be found in the work itself, as follows:—On the means of attaining to a true Philosophy. On the first simple or first natural Point. On the first Finite. On the second Finite. On the third Finite. On the fourth Finite. On the fifth Finite. On the pure material Finite, or water.

"With respect to the Actives, the series is as follows:—On the Active of the Point. On the Active of the first Finite. On the Actives of the second and third Finite. On the Actives of the fourth and fifth Finite, or on fire.

"With respect to the Elements, the series is as follows:—On the first or most universal Element. On the second or Magnetic Element. On the third Element, or the Ether. On the fourth Element, or the Air. On the fifth product similar to the Elements, or on Aqueous Vapour; where we finally shew, that in every drop of water is contained every single thing which had hitherto existed from the first Simple, as also the whole genus of Finites, Actives, and Elementaries; consequently that in a single drop of water is latent the whole Elementary world both visible and invisible.

"Now since causes and things caused are similar to each other, although they differ in degree and dimension, it follows that nature is similar to herself, and cannot be different in the larger system or elementary kingdom from what she is in the lesser; in the macrocosm from what she is in the microcosm; in a volume from what she is in a particle; hence in the elementary particle may be seen the quality of the volume, and in the volume the quality of the particle; from which we infer that the sun consists of the Actives which first originate, or those of the first and second Finite; particularly since it is the cause of all the subsequent mutations; the first motor of the things in its series; inasmuch as other things could not have successively existed except from the first Actives, or the solar space consisting of them. Consequently that the solar vortex and the vortex of the other stars consists of the first and second, hence of the most universal, Elements. That the sun itself, in the formation of its vortex, being surrounded with a crust of Finites of the fourth genus, was thus the original chaos of the earth and the planets; and inasmuch as this crust enclosed within it the sun, or the space consisting of the Actives of the first and second order, while the fourth Finites occasioned a pressure from without, such a chaos could resemble no other than an elementary particle; in which, in like manner, the Actives exercise a pressure from within, while the Finites or Passives occupy the surface; so that it was by a process the most simple that nature produced a chaos, from which she afterwards brought forth the earths; being thus similar to herself in her greatest as well as her smallest productions. That consequently the earth, when just produced, and in proximity with the sun, consisted of the fourth Finites, and possessed in the larger system, like the Finite in the smaller, a motion of its parts, an axillary motion, and also a local motion; so that in itself it was the representation of a large Finite; and as to its local and annual motion, the representation of a large Active; that hence both in the earth and in the other planets we may see what is the quality of the Finite and what the quality of the Active in its minute boundaries; and also in the chaos what is the quality of the elementary particle."

This, we hope, will put the reader in possession of the preliminaries requisite for commencing the study of the present Work; and we now proceed to make one or two remarks which are rendered necessary by the difference between the modern tendencies of philosophy and those which were apparent when Swedenborg wrote. At the same time it is pretty evident, that Swedenborg received comparatively little impetus from his contemporaries, but that the greater part of what he has written, wears the impress of his own active mind. He, therefore, needs not to be accommodated to this age any more than to that which has passed away; but it is the modern reader for whom, on his own behalf, we feel it expedient to make the following observations.

When Swedenborg wrote his philosophical works, modern scepticism had not attained that predominance which it has since exercised in European philosophy; nor had Transcendentalism, under the pretext of answering scepticism, admitted its conclusions, changing the form of their enunciation from the sceptical to the dogmatical. This has since occurred on the continent of Europe, and the breath of the movement has not been unfelt even in England. Here, however, the national temperament forbids that Transcendentalism should be known and received as a system; although notwithstanding some important conclusions of the system have deeply infected the metaphysical faith of the country. This it is that makes it incumbent upon us briefly to notice that state of mind which the majority of learned readers will bring to bear upon the Work now before us; and to declare *in limine*, that so far as Transcendentalism in any of the forms under which we know it, is the medium through which these *Outlines*, or the other philosophical works of the author, are viewed, so far they will be misunderstood; so far they will be seen not directly, but through a medium; and that medium composed of falsities in words and notions, which must alter and distort whatever they surround.

Now what is Transcendentalism? It had been argued by Bishop Berkeley in his ingenious *Dialogues*, that what we term the world is after all but our own sensations, and that given the totality of these sensations, we have no need of an outward universe. His logic was accepted as irresistible by "thinkers" in all countries, and at all events no counter-statement having the neatness, portability, and plausible character of the Bishop's scheme, was made at the time, or has been made up to this hour. If the principle of the *Dialogues* were true, the Irish metaphysician had demolished the validity of the external universe; and in so doing had achieved a triumph for scepticism which implied clearly enough those other victories that it was afterwards to gain in the hands of David Hume and his continental admirers and successors.

The Scotch metaphysician took the matter up where the Bishop left it, and, as it is supposed by learned philosophers, proved that the law of cause and effect was without foundation in the nature of things, and was but a prejudice, useful enough in common life, but not valid in philosophical argument. It was therefore the glory of this thinker, that he had repealed or rather disproved all real cohesion in man and nature, and made of the universe an incoherent nulliverse, a whirl of fleeting sequences, and a delirious "chase of Pan."

At this stage, his own countrymen, Reid and others, very properly rejected his whole theory, centre, antecedents, consequents, and all, as a useless and fruitless thing, one of the entities over the number requisite for mankind; and they betook themselves to *common sense,* as an asylum from monstrous ratiocinations, and a heavy check to absurd principles and conclusions. Not so the continental philosophers. On the contrary, Germany produced a mind, in the person of Immanuel Kant, that thought it worth while to accept this progeny of scepticism, thus self-condemned by its fruits, and to give it grave consideration, a positive form, and a life-long education and development. It grew up into transcendentalism, a system worthy of its seed, and directly perpetuating the powers and qualities of its parent scepticism.

The point of Transcendentalism was this, that whereas the arguments against the possibility of our seeing an external world, are unanswerable, let our world be freely conceded to consist of our own sensations, valid for us, though not for itself; time and space being "forms of sense," true of man, though not of objects. Furthermore as the law of cause and effect, and several other fundamental notions, are found to have no abiding place in the surfaces of sensation, Transcendentalism says here again, These laws are the forms of thought, true for the understanding, though not for objects, and therefore you may fairly declare that they are valid within the circle of that faculty, but not to be predicated or defended beyond it. For instance, we have a right to say that the universe has a cause in God, if we thereby mean that such is the way in which our minds are obliged to think; but if we further mean that our proposition is an outward or objective fact, independent of our own minds, we become guilty of an inconsequence. It is true that we have the idea of God, but how do we prove that there is a real object existing out of us, corresponding to that idea; that there is a God as an outward or inward object of reason? May not God be only the *pruritus* of our own uneasy faculties?

In a word the upshot of Transcendentalism was, to regard all sensation, knowledge and thought as subjective, and to make the individual believe all the manifestations of God, nature or humanity which are made to his mind, as so many presentations of his own being. In this way each man becomes shut in the case of an opake and impenetrable selfhood, which not only absorbs and destroys all outward truth, but makes it impossible to have any confidence in the existence of our brother man. To accept these consequences is the manner in which Transcendentalism has answered scepticism!

It will easily be seen that on the foregoing principles Transcendentalism utterly ignores all those reasonings which are based upon the truth of outward nature, and that it shews a long list of subjects of which the investigation is declared "impossible." Never in fact did any one man proclaim so many things "impossible" as Immanuel Kant: to limit the human faculties was his glory; to accumulate impossibilities was his science. Theology was impossible, and ontology especially was impossible; and indeed scarcely anything possible was left, saving nonentity and terminology.

Thus metaphysics, after dreaming a while in Berkeleyism, became rambling and delirious in Hume, and sank into confirmed idiocy or Cretinism in Kant, who, to the false movements and functions of past scepticism, gave a corresponding false organization or body, and endowed the monster with a power of propagating its kind, and filling the world with a lineage of abominable inventions.

We have spoken particularly of the Kantian Transcendentalism, and not of the manifold systems of Kant's successors, because it is the former which has had the greatest influence in England, into which it was slowly introduced by Coleridge and others, long after it ceased to animate any particular school in Germany. And we assert that the identical principles of Idealism, Scepticism and Transcendentalism, have so corrupted thought even in England, that scarcely any subject or problem can appeal to learned and thinking men with its direct natural force.

Thus as the world without is referred to the senses of man, and denied to exist except so far as it is perceived, so the inner world of which the mind is a part, is similarly referred to other faculties, and made to consist entirely of their perceptions. The consequence is, that both spiritual and natural experience are shaken to the base, and all scientific vision of the deeper parts of nature is set down as a dream, in which the figments of the mind are mistaken for the unattainable truth of "things in themselves." In this case sensualism with locust wings advances over the earth, till there is not a green patch left to sustain animal life, or to cheer the traveller's eye, or soften his path. The legitimate end therefore of all this high-flying metaphysics, is no other than that old Epicureanism, "Let us eat and drink, for to-morrow we die."

To one who is deeply committed to this unhappy metaphysic, it is in vain to cite experience of any degree. To whatever sphere it professes to belong, it is the mere child of the mental faculties. If God manifests Himself, He is but an idea of the pure reason; if the spiritual world is represented, it is but the conceptions of the understanding; if nature lies outspread before the eye, both it, and the eye itself, are but sensations. The matter is not at all mended by the Kantian admission of that most immoral and absurd of "all possible worlds," viz., the world of "things in themselves;" for the cognizance of these things, according to Kant, their inventor, is impossible.

Now it may easily be seen what a bearing these principles must have, in indisposing the human mind to an attentive consideration of Swedenborg's writings, in which the questions of Idealism, Scepticism and Transcendentalism are unasked and unanswered, and the objects of reason are treated as outwardly true, and the outward spiritual world itself, independent of our perceptions like the natural world, becomes a direct object of human knowledge.

Among the least sincere parts of metaphysics, we may justly reckon its continual profession of the dangers of materialism. Not that materialism is other than a gross error and evil, but much has been wrongly classed as materialism which properly comes under the designation of *reality*. Many writers exhibit great sensibility on the score of materialism; and this, it may be feared sometimes, not with a view to curbing ill-directed sensuality, but in order to banish external and commanding truth from the mind. They allege the grossness of the mind to the score of the material body, much as improvident men blame the stars, and as sinners of all classes make circumstances the pack-horse of their sins. The truth, however, is, that moral wrong is wrong precisely because it is *not* material; the actions of the body are qualified by good and evil only in proportion as they are actions of the spirit. Automatic or purely organic action, or the lower forms of mechanical action, cannot exhibit sensuality, or in any way call down blame or praise; although according to the above metaphysicians, the deadest of things, for example, a stone, ought also to be the most vicious. But it is plain that the belief in matter, and in the necessary embodiment of the human spirit, has no bearing whatever upon the question of materialism considered in its moral relations. The only subject worth a moment's consideration is, whether the persistent attribution of form, and body, and ultimately of mechanical and geometrical laws, to the human soul and spirit, does amount to materialism, or not. And here we at once answer that it does not. It is impossible to conceive matter without form,—impossible even for the most learned Aristotelian. Again, it is impossible to conceive form without substance,—impossible even to the Berkeleian and the Kantist. But materialism, as we understand it in the opprobious sense, does not imply a belief in the formal and substantial existence of the mind, (*e.g.* as a brain,) but rather a predication of low and unworthy forms of the human essence. Let us illustrate this by an example. If I ask you of the distinctive essence of Westminster Abbey, and you answer me that the stone of which it is built is that essence, I am in this case bound to accuse you *pro tanto* of materialism. For it is evidently the *form* of the Abbey, the architect's *plan*, which gives the building its individuality. The same stone might be ranged differently on other plans; but the same plan would continue the same in whatever latitude it was built, or with whatever materials. The very stone, it is true, has a form, and could you but see it in its intimate constitution, a stupendous form, but here its form is not made use of, excepting in so far as it lies at the root of the hardness, durability, &c., or the *general* properties, of the stone: consequently it is the stone considered as mere matter, not as form, which enters into the construction of the Abbey. In every orderly gradation in which aught worthy to exist is founded and upraised, the subsidiary forms count but as matter to those above them, and these again, in their turn, as matter to others higher still; or to consider the descending scale, the highest forms enter into those beneath them, and group them in their own manner; and the edifice or organ thus produc enters into a lower series, and arranges its parts or matters into new groups; which thus become fresh forms capable of exerting a corresponding operation upon other materials again; and so forth. Thus all things are indifferently matter, or form, according as they are circumstanced or viewed. And the only materialism for the understanding consists in attributing the operations of high forms to low and inadequate ones, *i.e.* to matter as a relative being. Thus when the operations of the mind are said to depend upon the *nervous pulp,* we are at once struck with the materialistic *animus* of the expression. And why?—simply because the construction of *a pulp* is felt to be lower than the form of the brain, which is the indubitable form and embodiment of the human faculties; and because the senses, to which the *pulp* is presented, are allowed to climb into that theoretical faculty by which the higher forms are discovered, and to insinuate that the *pulpy appearance* exhausts the reality, and that there is no wondrous order and mechanism penetrating the pulp, by which the brain is made receptive of its functions. In a word, it is not the bare annexation of form, quality, properties, space and time, real or analogical, or matter either, to any subject, that can degrade it, but the misplacing of the various degrees of which these predicates consist, so that vegetable effects are assigned to the mineral, or animal effects to the vegetable, or human effects to animal organization, or lastly, divinity to nature.

Thus much we feel it necessary to say to the reader of the *Outlines,* in rebuke of that exceedingly artful charge of materialism which the metaphysicians are so prone to make against all *real* views of the soul; in which views, as we said before, we fear it is the commanding reality that is repugnant, and not the materialism. For if the human mind is conversant with the gross bodies, forces, properties and things of sensation, as it undoubtedly is; and if there is nothing in the higher faculties corresponding in palpable reality to sensation; if the understanding and the reason have no real but only a formal validity in their ideas and conceptions; then how fearful the weight and preponderance of the five senses! They have all things on their side, with no counterbalance whatever. If, however, as we maintain, *all the intellectual faculties are likewise senses,* and if their objects are real, outward, forcible and impressive, like those of the visible world, then there is some hope of an equilibrium between the inner and the outer man. In moral battles, reason may have sense with it as well as against it, and in hours of despondency, faith may find comfort in the endowment of sight.

En passant we may note it as curious, how readily the downright *nonsense* of the theologians, finds its counterpart in the cautious *non-sense* attributed to reason and understanding by the metaphysicians. The one appears to be the organ of which the other is the object: the one generates contradictions; the other adopts the negation which is the result. $1-1=$Theological Mystery; $0=$Philosophical Faculty. We observe that it is the same amount differently expressed.

The failures of philosophy in the above respect, have in truth a simple root, and one which it is not difficult to discover by the light furnished in the writings of Swedenborg. Neglect of facts, internal and external, as the basis of certain very ordinary inductions,—this neglect, which Bacon came to signalize in his own day, is the source and cause of the shortcomings of metaphysicians ever since. 1. As a principal error, man has not been steadily regarded as a finite being; and consequently the investigation of forms, which is a path of fruitfulness, has been superseded by a barren quest after unformed matter, and disembodied life; both of which are necessarily inappreciable, and finitely speaking indeed, are non-entities. 2. God has been regarded otherwise than as given in revelation and experience, and consequently philosophical theology has had no basis and has made no progress. 3. Nature has been limited to the phenomena presented to the senses, because its internal parts, like the human powers, have been considered divine and infinite, and consequently occult; in other words, nature has been emptied of series and degrees, and principles have consequently been deprived of their legitimate unbroken connexion by similar means with effects and ends. These are some of the reasons for which philosophy has remained a blank, with much pretension on its side, and small human usefulness.

This condition of metaphysics has undoubtedly arisen from great theological perversions, which in their turn are due to moral causes; since "God appears to every man according to the state of each;" for philosophy ever has been, and ever will be, the servant of the reigning theology, to do its bidding, either tacit or confessed. Yet we may, without deeply investigating the moral estate of the church, observe one fact with respect to the intellectual constitution of philosophy, which will go far to account for its inertia and incapability; we mean the lymphatic temperament it manifests; the lazy attitude in which it performs its tasks; the easy-chair study of its own consciousness as the grand book and volume of instruction. The poor Hindoo, gazing into his navel for a resolution of difficulties and a comprehension of mysterious things, is worthily engaged in comparison with those who are occupied year after year in "probing their consciousness." The only *fact* of which they are thoroughly conscious in their introspections, and which might be usefully recorded and remembered, viz., their flat ignorance of themselves, is, alas! not written among their discoveries. But what profit is there in studying a consciousness which does not involve among its conscious elements the knowledge which they seek. Or if it does involve this information, then the information is already obtained, and there is no need to seek it. We must be sorely perplexed indeed when we do not know our own minds. But men have yet to learn that the consciousness and the *self* may be totally different things; that *Γνωθι σεαυτον* is a precept which enjoins anything but egotism.

The notion of eliminating a philosophy from the analysis of consciousness, is so profoundly, so intimately absurd, that it is extremely difficult to discuss it without falling into truisms which it seems ridiculous to enunciate. The office of man is far other than at any point of his life to bring himself to a stand-still, that he may examine his own wheels and mechanism. The fact of motion, of action, of will, is the grand human potency, and this fact is necessarily abrogated to the last degree, and as far as may be, unnoticed, during the pretended examination of consciousness. The business of life, and especially of philosophy, is to alter and enlarge and improve the human knowledge or consciousness; by no means to fix its limits at any given or any possible stage. A philosophy which seeks to rivet a particular consciousness as a boundary upon the human mind, is the organon of a preposterous conceit, and would consistently nip childhood in the bud, prevent all improvement, and deny the possibility of education. Yet such a philosophy is the inevitable growth of that false view, that man is not finite but infinite, that he is a life, and not a recipient of life.

Had the latter point been thoroughly acknowledged, we should then have had before us a creation and a subject in which everything was knowable; a universe of forms generating qualities, and adapted to uses, which was the object of science and organic philosophy in all its departments, from Theology to Cosmogony. On the other hand, the denial of form to the mind and soul, and the consequent tacit predication of infinity of both, has made knowledge cease with the senses, and the surfaces thereof, and has, in point of power and intelligence, finited man's reason in many respects to a degree much below the instincts of animals. In theology the same cause has degraded the Christian below savage tribes, and made the consolations of that Gospel which brought life and immortality to light, incomparably inferior in reality and distinctness to the poor Indian's belief in the Great Spirit and the happy hunting fields.

Thus much it has seemed necessary to say, in order to vindicate the present volume from coming under the judgment of the philosophies of the day; and in order to warn its readers to put aside metaphysical notions and prejudices, such as the necessary infinity of spirit, the identification of form and mechanism with matter, the existence of "things in themselves," the assertion that sensations are unlike objects, and the possible subjectivity of any idea in an absolute sense. For these are but forms of that dense "intellectual cataract" which philosophy has drawn over the intellect, and which, binding down mankind to a groping sensualism, prevents all direct contact between man and his field of alteration and improvement, viz., the outward and inward creations of God, in which he is a part among parts, a body among bodies, a spiritual form among spiritual forms.

We had intended to give a brief account of the subject and scope of the *Outlines*, but this may be readily gathered from the Index of Subjects appended to the volume. In the meantime we beg to remind the reader, that the work was pul fourteen years before the first of the Author's theological treatises, and that during the interval his mind was undergoing continual and rapid progress; so that it is by the latter treatises alone that he is to be finally judged, although his philosophical works are indeed a considerable help to a correct appreciation of his labors as a whole. Nevertheless his theological works are so far superior to his early productions, that we are bound to put in a distinct *caveat* against a last opinion being formed from any others.

The reader will see at the first glance that the work before us has a mechanical tendency, and aims at a reality of knowledge on the deepest subjects, such as the moderns themselves, often accused as they are of a mechanical spirit, would scarcely venture to hope for even in the sciences of chemistry and physics. Yet on account of this very tendency, we augur that it has a function in the busy world, and will be acceptable to its true citizens. It tells us not to be ashamed that we "live in a mechanical age." The laws of mechanics—do not they, too, come from the infinite? May there not be superlative perfection in *them,* as well as in any other laws?* So long as the laws of the soul are unknown, how shall we be certain that the deeper analogies of mechanics are not those very laws? Let us then look for a moment at the privilege we enjoy, in that we are among the first to "live in a mechanical age."

Remark at the outset, that the question at present is not between the age of gold, and the age of mechanics. Were we still living, an undiseased generation, fresh from our Maker's hands, in his glorious primeval universe; at home in pure and most perfect love in the celestial warmth of creation; reading the Word only in the works; suckled by the maternal earth, or fed with nectared fruit, in quick anticipation, by the obsequious trees; brotherhood and sisterhood, wedded love, and family nearness, the unfailing promise of a heavenly society; space not putting asunder those whom God had united;—were we still enduring in this original estate, there can be no question how superfluous would be the officious ministrations of art;

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* *Outlines,* p. 109.

and with what well-founded composure we should repugn for ourselves the influences or offers of a mechanical age. But this first estate has gone, and it is the laziness of philosophy to regret it. That sensuality which was once the fall, has become the floor of a new heaven, and henceforth the natural man is infinite in the infinite. The conditions are inverted. Natural truth has become the basis of all truth; the necessary foundation of society; and mechanical truth is the *ultima ratio* of natural truth. The question, then, lies between mechanics, and rude, unskilled adaptations: between the casual and ignorant gratification of animal wants, and the steady maintenance and healthy expansion of the body of the soul: between occult qualities in the sciences, abstractions in philosophy, and portentous mysteries in theology, on the one hand; and definite objects of all degrees on the other: between the affections reduced to blind instincts, and separated by the chasms of space and time; and the same affections intellectualized, and combined naturally, and hereafter morally, into an indissoluble society, which the laws of creation, equally with the influences of the spiritual world, tend to perpetuate for ever. In a word, the dispute is between mechanics as an exponent of the inward sphere, and an indication of the future time; and metaphysics, hanging in middle air over the fruitful earth, bewailing a supposititious past, dreaming of an unlikely future, and in the meantime leaving the present to the conduct of the abused spirit of mechanics. The issue is as certain as the triumph of capacity over incapacity, or as the preponderance of something over nothing.

In justification of a mechanical element in philosophy, we might fairly appeal to the important part which the mechanic sciences are performing in the advancement of the race; we might shew that they tend to the production of competence, to the spread of knowledge, to the mitigation of suffering, to the restraint of crime, and to the communion of mankind, with all that is implied in these prodigious qualifications. But fortunately it would be useless to dwell on a point which is never disputed. Dismissing then the innumerable services which the mechanical spirit performs in the groundwork of human society, let us retrace our steps to its first manifestation in the writings of Swedenborg, and hint at one or two benefits which a true application of it promises to philosophy and theology.

Observe, however, that by mechanics we understand the whole doctrine of forms, as either analogically or really mechanical; and when we say, "analogically," we imply, that the world of the soul itself is such, that it is connected with nature without the intervention of any necessarily occult or mysterious laws; in a word, that all spirit and all nature is but One Creation with its parts rationally contiguous. But we do not limit mechanics, which, as Swedenborg says, "is conceived and born of the elemental kingdom," and indeed of the spiritual world, to material machinery, but comprize under it at present, for the behoof of the argument, all the possible states of animate machines, and of living finite beings.

The first grand fruit of the mechanical spirit, is the infusion of industry into the soul of philosophy. For what is now required of philosophy? Simply this, that it shall be the Science of sciences. The mechanical spirit insists that philosophical teachings shall be equally definite and real with the facts of the senses, and the texture of positive knowledge. No umbilical contemplations, no *non-sense,* have the slightest power with the student who has acquired positive knowledge in other departments. If philosophy has "no assets," it must work and acquire. It must till the ground of creation, to produce the noblest crop of all, which nature will acknowledge and claim as her own production. Its results must not be contrivances, or inventions, or wooden systems, but juicy fruits, which have absorbed the choicest dew of the sciences, and embodied it in forms of beauty, brilliantly real beyond competition, and big with utility. And whenever philosophy mutters "impossible," it must submit to be treated as a forward menial, usurping the dress and name and functions of another, and its education must recommence at the bench and in the workshop of the sciences. In short, philosophy must teach in learning; and discern the nature of man from his extended works, from the entire body as the physiognomy of the soul, from the great frame of nature as the means to an end, and the analogue of humanity, from revelation as a divine fact and enlargement of nature; from the highest powers which the human mind has yet attained, considered as means to a further elevation. It will then have something tangible to present, which "a mechanical age" can handle, and the intellectual months will offer their yield of precious grains, each in his season. In this case the sciences themselves, uninterruptedly supplied from the fountains of doctrine, will be but philosophy in its lower derivations, and will carry its tone and its informing spirit to the humblest door, down to the very limits of the senses. Thenceforth philosophy can never fall; for to attempt to shake it, would call forth not gowned disputants, but human nature in its defence. For what, after all, *is* true philosophy, but the rational mean to an unbounded charity, the quick-eyed intelligence of brotherly love; a thing appreciable in one form or another by all the dwellers upon earth.

And if a philosophy is naturally indestructible that rests upon the basis of the sciences,—if a philosophy comprising real metaphysics, metamechanics, metacosmics, metachymics, metazoics, and the other powers of knowledge, be "absolutely safe from harm by aught that can befall in this sublunary region," who can doubt that theology also may be similarly exempt, when it, too, acquires a natural foundation, and is equally positive, and directly connected, with the truths of a mechanical age. Once for all God has come into nature; His truth is now entering into the natural sciences. To pass over the other fruits of this great Advent, and to instance perhaps one of the least, will not the corroboration of theology by the various spheres of nature and art, tend to remove controversy from the ground of principles which ought never to be questioned, to the outer courts of truth; and while perpetuating the intellectual labors of the world as a means of heavenly prolification, preserve unbroken the joyful sabbath of the inner man? And as that machinery which is inferior to the hand, has yet released the hand from many an unworthy toil, and will in the end enfranchise man from brute occupations, and leave his body free for its own peculiar works; so in like manner will the sciences, as the dead machine of theology, address themselves to the confutation of scepticism, to the settlement of disputation, and to the management of those insurrections of the mind, which though comparatively harmless in physics, are pests and heresies in a church; and thus will leave Revelation at leisure, for its own high task, of the moral regeneration of mankind. We look upon it, therefore, that in the coming time, the religiously scientific mind will be the true Church Militant upon earth.

But be this as it may, one thing is certain, that the last of the non-mechanical ages has passed for ever. It remains then to make the best of mechanical things and mechanical views, or to connect them with spirituality, which is impossible without a certain *ratio*, or common organ partaking of both. Such an organ do we happily find in these wonderful writings of Swedenborg. They exist to give ends to science, the precision and flexibility of nature itself to philosophy, and to theology a conjoint natural and divine Realization. In place of the garden of Paradise, they formally point our vision to the City of the New Jerusalem, *in the midst of the street* of which, as in a second paradise, is there the tree of life. Different though the garden from the city, yet the one is reconcileable with the other; nay, the crown of the one, or the tree of life, is to exist within the other.

But perhaps we have dwelt at too great length on the seemingly mechanical tendency of a portion of Swedenborg's philosophy. We have, however, taken this course, from the experience that mechanical views have been alleged against him as a special disqualification. To remove which objection we have endeavoured to shew, that mechanics are the last exhibition of spiritual forces, and that so far as they correspond to those forces, and work for spiritual ends, they too, like the human form, are spiritual forms, and not material. It is true that we might have shewn, on the other hand, that mechanics is too gross a term to be adequate to the state of inner forms as opened by Swedenborg, but we preferred to meet the accusation on the very ground of the accusers. And we now, therefore, tell them, with great plainness, that *in an eminent sense* we admit their charge, but we further declare that they will find that Swedenborg, not of his own right alone, but by nature and Providence, furnishes also the just spiritual complement of the Mechanical Ages.

CHAPTER I.

THE

INFINITE,

AND

THE FINAL CAUSE OF CREATION.

To Eric Benzelius, *Counsellor to his sacred Majesty the King of Sweden, Doctor of Theology and Bishop of East Gothland: from his loving Kinsman.*

When in one and the same individual we venerate merit and acknowledge the source of personal kindness, especially if other and extrinsic ties be superadded, in such case, through the harmony of nature and circumstance subsisting between us, we embrace him with perfect love. In you, Right Reverend Bishop and beloved Kinsman, I venerate a wisdom equal to your exalted rank, and worthy of your sire; and the learned world with one accord confesses the same. In you I acknowledge the source of personal benefit, inasmuch as it was by your advice and wishes, that my mind, (then ripening and eager for study, though hesitating and ignorant nevertheless, as at that early age it is wont to be, to what pursuits to turn,) was directed to the present and similar subjects, which were auguries of a prosperous career in literature. Moreover there subsists between us the bond of relationship. From this threefold ground, that is to say, from venerati for your merits, from acknowledgment of your kindness, and from family ties, springs sincere love, which I trust you will permit me here to put on record. And as it was at your instigation that I applied myself to these studies, so I hope you will in a measure acknowledge this offspring of my powers, poor though it be, as in some part your own; and therefore allow that of right it should be dedicated to no one but yourself: and I claim for it your favorable consideration, if not on its own account, yet because of the cause it pleads; if not for its merits, yet for the love you bear its author. That your life may be as long and happy as those desire who are your relations by love,—this, and more than this, as I love you more, is the heartfelt wish of,

Right Reverend Bishop,

Your most obedient Servant and dutiful Kinsman,

EMANUEL SWEDENBORG.

PREFACE.

You here see philosophy reasoning upon the infinite and the soul, yet using the most familiar words and a humble style, and endeavoring to divest herself of the aid of metaphysical terminology; and this, lest any obscurities or sublimities of expression should cause the mind to dwell upon words, and turn it aside from things and the subject. When any high theme is treated of, a vigilant care should be exercised to avoid the minutest expression that can make the reader pause. We have, therefore, been anxious to present our philosophy under the simplest aspect, and in a guise no way different from the familiar speech of the world.

Philosophy, if it be truly rational, can never be contrary to revelation: that is to say, if the rational principle partake of the soul more than of the body: or the reason arise from no gross corporeal instinct, whose end it tends to realize, forming the soul by use and exercise for perpetual obedience and consent thereto. Reason or understanding is a faculty partaking both of the soul and the body, whose end is, to enable the soul to be instructed through the body and its organs, that afterwards it may dispose all things in such an order and connexion, and call them forth with such distinctness, that a rational principle may be the result. The end of reason can be no other, than that man may perceive what things are revealed, and what are created: thus the rational cannot be contrary to the Divine; since the end why reason is given us, is, that we may be empowered to perceive that there is a God, and to know that he is to be worshipped. If reason be the mean, endowed with the faculty and power of perceiving, and if the actual perception be the end, then the mean, in so far as it is correctly rational, cannot be repugnant to the end. The very mysteries that are above reason, cannot be contrary to reason, although reason is unable to explain their grounds. But of these subjects we speak in the following Work.

CHAPTER I.

THE INFINITE, AND THE FINAL CAUSE OF CREATION.

§ I.

In order that we may be favored and happy in our endeavors, they must begin from the Infinite or God, without whom no undertakings can attain a prosperous issue. He it is that bestows on all things their principles; from whom all things finite took their rise: from whom we have our souls, and by whom we live; by whom we are at once mortals and immortals; to whom, in fine, we owe everything. And as the soul was created by Him, and added to the body, and reason, to both, in order that the soul might be His: so our thoughts, whether we revolve them within, or utter them in words, or commit them to writing, must always be so directed, as to have their beginning and end from Him: whereby the Deity may be present with gracious favour, as the First and the Last, in either end, as well as in the means.

Rational philosophy—what.

Human philosophy and wisdom are for the most part anxious to be taken into company with theology. They glory in a manner in perceiving and scrutinizing divine and transcendent subjects. Often too they accompany theology to her very oracles and mysteries, and refuse to credit or embrace their responses, until after they have consulted the tribunal of reason, and endeavored to attain to some grounds of belief. It is the distinctive mark and character of the philosophical temper not to bestow unhesitating assent on matters of dubious, unrecognized, and obscure pretensions, unless concurrently it be persuaded by a statement of causes, and by its own peculiar mode of philosophizing, and its own analysis; and unless its illustrious companion, theology, vanquish it in fair, even argument. This, I say, is the mark of the philosophical temper, and a disposition of this kind will not be withheld from sacred subjects by the dictum that they are revealed. It holds that it is living in a state of nature and in the utmost freedom, and is bound to acknowledge no superior but him that can command its reason, who alone has the force to tie its hands. I am now speaking of things as they are, not as they ought to be; *de factis*, not *de jure*. And although there be little that the mind can perceive in the natural sphere, and infinitely little in the Divine, still our philosopher thinks that he can and ought to perceive; and whenever he does not perceive, he either declares the matter to be inexplicable, or denies it altogether, or wraps it up in the darkest words, to prevent all possibility of convicting him of ignorance. So ambitious is the mind, that it endeavors to philosophize to the utterly unknown, where it fixes the boundary, not of its own knowledge merely, but of the knowledge of the whole philosophical world besides.

The infinite is the difficulty of philosophy.

As the mind, in the course of philosophizing, peers into and courses over finite nature, its parts and its whole, it cannot but at last arrive at the utterly unknown and inexplicable, *i.e.* at the infinite, and the essence of the infinite; and as the infinite is identical with the non-finite, the mind there stops,—there finds an insurmountable and impenetrable difficulty, and remains involved in its Gordian knot. And when by a thousand curious efforts the philosopher labors to know what the Infinite may be, what the infinite God is like, and what can be the nature of an essence that requires to be conceived as without end or boundary: what that something is of the qualities of which philosophy is doomed to perpetual ignorance; he then considers and enquires whether such infinite be identical with the Divine; whether there be aught in nature that can be said to be infinite; whether the infinite is beyond nature, or the contrary; and whether its qualities are investigable by means of nature, or not. For where the human mind is not hindered by circumstances, or oppressed with cares, it ever loves to rise and mount; and the steeper the difficulty, the more heartily the mind engages with it; for it burns to possess denied knowledge, and to tread forbidden ground; longs also to know secret things, and glories in grappling with difficulty: and the longer it sticks in the knotty point, provided there is hope that aught approaching to perfection of knowledge be attainable, the more earnest and burning do its efforts become. The pleasure of the pursuit lives and feeds upon itself, and dallies with the laboring soul, winning it over to its side; and this continues until the mind has found what it sought, or else in sheer weariness is forced to leave it as hopelessly inexplicable; although even in this case it is not without reluctance that the philosopher can consent to forego his emprize.

Speaking generally, there is no relation between the infinite and the finite.

The more deeply human wisdom commits itself to the investigation of the divine or infinite essence, the more deeply is it involved in a labyrinth. For example, let THE INFINITE be the difficulty that the philosopher is impatient to solve. As soon as he arrives at the point where he begins to enquire into the qualities of the infinite, he at once whets his mind, consults all the oracles of reason, and collects a thousand arguments from whatever particulars are fixed scientifically in his memory. These arguments, however, be it observed, are taken in the first instance from the finite sphere; for in consulting the oracle of reason, they can come from no other source. Besides, the reasoning mind knows none other than the finite, consequently can produce none other: for it is informed and developed by finite things, and through finite senses; and seeks the unknown by the analysis of the known: and moreover, being finite itself, none but finite things can be known to it. In the first place therefore the philosopher institutes a comparison of a general kind between the finite and the infinite; or between a living, intelligent and active finite, and a living, intelligent and active infinite. But rational philosophy at last rejoins, that no comparison or relation can subsist between the finite and the infinite: that if the philosopher must enquire, by relation and proportion, into the essence of the infinite from the essence of the finite, the infinite will necessarily appear null in relation to the finite; or else the finite, null in relation to the infinite. For the infinitely small becomes proportionately as nothing in relation to the greatest or least finite, if we may so express ourselves. On the other hand, the greatest or least finite becomes nothing relatively to the infinitely great. Whence if we postulate either the infinite or the finite, the other perishes in the comparison.

Specifically, with regard to extension and space, there is no relation between the infinite and the finite.

The human mind, however, does not rest satisfied with even the above answer, but in the course of its enquiries into things, descends to one detail after another, and distinctly proposes to solve the difficulty, by scrutinizing in the first place every hole and corner of the subject. As yet indeed it does not thoroughly doubt, neither deny or reject, nor yet affirm, but cherishes the hope of still solving the question, so long as anything whatever remains untried. It therefore now goes into details for the enquiry, to enable it the better to see, whether what at first appears impenetrable and inexplicable, may not somewhere, or somehow, be explained. And for this purpose it directs its attention to magnitude, space, extension, form, or to quantity and quality, or other similar geometrical conditions. And as it knows that there is an infinite in the least sphere, and an infinite in the greatest, so it compares the substances, quantities or qualities of the finite with the infinite; and in the first instance probably supposes, for the supposition is extremely natural, that God is the least or simple element of quantity and space, and likewise the greatest. Yet as the reasoning goes deeper, the inference comes, that if God be the least, then he cannot be infinite; for the least or minimum of quantity or quality still retains somewhat of the finite; according to which, God is not infinite: and so the mind plunges deeper into the knotty labyrinth, and can hardly emerge from it again. For what is that minimum which is infinitely little? What is the infinitely little, or the infinitely least? Such an entity is impossible, and therefore there is no escape in this direction. There is no quantity infinitely small. All quantity must be either finitely least, or it must be a simple of some kind; or the subject must be infinite without predication of quantity, magnitude, space, extension, form, quality, or smallness. Furthermore, as there can be no proportion between the infinite and the finite, there is therefore the same between the least finite and the infinite as between the greatest finite and the infinite. The difference between the two finites, or between the greatest and the least of nature, is itself finite; and therefore makes nothing relatively to the infinite; so that no possible ratio exists. Here then the mind is again at fault, and this time is deeper plunged than ever in the formidable maze.

In respect of motion and celerity, there is no relation between the infinite and the finite.

As then the infinite is not the least of substantials, the least of extension, the least of quantity, or the least of form, that is to say, is not the least of geometrical entities, the human mind goes onwards, turns over the subject in every way, and asks whether the infinite may not be the pure and least actuality; at once the least and the greatest in motion, in celerity, in motive force; in short, whether it may not be at once the least and the greatest of mechanical entities? The mind is aware that no finite can exist without a cause; that nothing can result or happen from causes without a mode; that modification can never take place without a change or variation of limits, either of those of the parts or the whole: that nothing can experience such variation of limits, or of the parts and the whole, without motion: that motion cannot exist without a substance that is moved: and that no substance can undergo motion without assuming reference to degrees and moments, which give birth to succession in celerity, or what is the same thing, in time; and hence to motive powers in mechanics. As then motion or mode supposes the finite and substantial; or as the mechanical always immediately supposes the geometrical; and as the infinite cannot admit of modification, the mind concludes again that the infinite cannot be the greatest mechanical entity in the sphere of leasts; more especially as it is not the least geometrical entity; the former being a causate and effect, while the cause and efficient lies in the latter.

Is the infinite the pure and simple?

Still, however, the mind is dissatisfied and perplexed, and to enable it to investigate the essence of its infinite and its divinity, it passes analytically from geometrical and mechanical grounds, to a something analogous to the geometrical or mechanical; to something conceived as pure; to an entity that is not finite; that is indivisible, not extended, not consisting of parts, and therefore neither formal, nor modified; in a word, to the pure simple. And in this it recognizes a kind of primitive, causant, and agent, preceding the state in which finites can exist from it, and finite existences subsist. For extended entities must originate and subsist ultimately from non-extended: entities possessing magnitude, dimension, space and form, must come from entities destitute of these categories: limited beings from non-limited: geometrical entities from geometrical points: in a word, all compounds from relative simples; and these latter from positive or pure simples. But if the pure simple be the primitive, from which compounds could exist by succession, as the limited exists from the unlimited, the extended from the non-extended, the geometrical from geometrical points, or as numbers from simple units; still they could not have existed without a mode, or some analogue of a mode; nor without reference to some sort of limit in the simple, although it may be only a single limit, the simple therefore being not finite; for the finite must consist at least of two terms, or of two ends; and therefore must originate out of the multiplication of simples in a simple mode or analogue of a mode. The result is, that still the mind does not see that it has approached the essence of the infinite, because the infinite is devoid of all parts, terms and modes; and moreover involves nothing that can be said to resemble geometrical and mechanical entities.

Is the infinite eternal?

Still finding himself here entangled in an inextricable difficulty, the philosopher turns to other sides of the question, and considers whether God be infinite, or not; or whether there be any infinity in respect of time; or what amounts to the same thing, whether there be any eternity, or not? Generally speaking the conclusion is, that there is nothing but has had an origin. When anything is presented as existing, there must be a commencement, time and source from which it began to exist. No entity or actuality can possibly be, without having an origin, if not within myriads of years, at least within myriads of myriads; or if not within these, the mind only multiplies and multiplies again innumerable myriads by innumerable other myriads, until it supposes that it hits the origin by this process. Now therefore it occurs to the philosopher, that there was a time when God took his rise, according to which he cannot be eternal. Yet He is styled eternal, and eternity is time without end, or is, in respect to time, the infinite we seek. And time itself is no more than a peculiar relation to modes proceeding from finite and substantial beings; like celerity in motion, namely, its successiveness; and denotes only the degrees and moments thereof; and thus is like to, and almost identical with, celerity; and consequently is mechanical, and therefore similar to the geometrical; for where there is no substance there is no celerity, and where there is no celerity there is no time. Pondering these considerations, the mind doubts and hesitates respecting the existence of eternity, and whether there is aught from eternity; aught that has never at any time had an origin, however far back such origin might be in multiplied series of myriads of years. It falls then again into precisely the same difficulty, and stumbles over this identical and inexplicable first question: particularly as quantity, space, motion, time, and all things, conspire and consent naturally and rationally in declaring, that there is no infinity in any one of them.

If the philosopher be determined of purpose, he does not cut the knot, or reject the difficulty, until he has wandered over the whole of rational philosophy, both in general and in particular, and at one time diffused, at another concentrated his attention, and divided, and again divided, and multiplied by degrees and powers, and gone from one deep part of the question to another, and this repeatedly; and until he finds that although in his calculus he can apparently approach the indefinite, yet that nevertheless he is coming no nearer to the infinite, or to anything like it, or to anything without end. At last, when he sees all these impenetrable mazes, when he has had such repeated experience of their difficulties, and has found that they all combine to form one and the same unfathomable problem, viz., this, that by all the reasons of the case no infinite can possibly exist, because it does not exist for any rational, natural, or geometrical analysis,—after this result, he secretly concludes that the divine essence is probably not infinite, but indefinite, and the least and the greatest in all things: and as he sees in the greatest too a natural and geometrical condition, or an analogue of the least in quantity, space and time; he guesses that the Divine is the prime being of nature; and consequently that nature and God are in a manner one and the same. And thus occasionally the philosopher may at length, by his own imperfect investigations and analyses, become a worshipper, not of God, but of nature.

§ II.

The subject taken up, and concluded in the affirmative.

We have hitherto shewn how the human mind, in philosophizing concerning God and the infinite, at last may incline to the wrong side, and no longer see how an infinite or eternal being is possible: or how anything can exist that is absolutely devoid of extension, space and matter; devoid of all attributes or essentials that have any similarity to geometrical, mechanical, and finite things; or to anything whatever that can possibly be perceived by the imagination. I will however make common cause with the philosophers, so far as to admit that by no comparison with finite and perceivable things, and by no similitude, and by no force or faculty of the soul and the understanding, can we penetrate into anything that is in God, or in his infinity. I will also go further, and grant that not angels,—if the reader believe in angels, but whether or not, suppose for the present that they exist, and suppose that their souls are similar to ours, or even not similar, but more sensitive, perfect, pure and wise,—I grant, I say, that not even such beings can penetrate into the essence of the infinity of God. I will further add, that from reasoning of this kind, there is no help against our falling into doubt respecting infinity. For we cannot perceive it by analogy with what we know already; on the contrary, the object is in a manner nothing in relation to all our knowledge; and consequently, all respect of the infinite by the finite is inevitably lost.

Ought we to reason about infinity?

But perhaps the reader thinks he has cause to object, that philosophy has no right at all to reason upon the essence and infinity of God, since such a procedure is vain, and leads direct to errors; but that we ought rather at once to comprehend and embrace it in faith, as a sacred, revealed, and indubitable truth; for whatever is proved by Holy Scripture, stands in no need of proof by reason, by rational philosophy, or by geometry: and whatever is proved by the infinite is proved in all these ways quite sufficiently. I confess that this is in all justice the preferable view, and that reason may properly be banished from mysteries and holy ground; and moreover, that those persons are the happiest to whom it is given by grace to do thus. Nevertheless it is impossible to deny, that there are vast numbers in the philosophical world who have no choice left in this particular, but who fall into deep thought on the divine essence. For the law of humanity is, that if the mind begins to reason, it cannot help going deeper and deeper. Not only is the pleasure of the pursuit heightened and increased by the exercise, but it strongly tends to fix the mind upon the object, and makes it descend into particulars and specialities one after another, leaving it no longer free to curb its ratiocinations. There cannot be the shadow of a doubt, that the human mind has an innate desire to philosophize on the unknown, and all the more if God, the soul, or human salvation, are in discussion, or any other subjects that our thoughts and minds are ordered constantly to keep before them. Every one, however, has not the power to dictate the manner in which he shall think, and to adhere to that alone. Thus, as we said before, the persistency of the philosopher is natural and human. As then it is human for the mind, when thinking, to choose to think philosophically, we are forced to say, I see that it is so, although it ought not to be so: I see that on these subjects it is wrong to philosophize, and yet that men do notwithstanding reason philosophically; although they are unable to conceive, still they desire to conceive; and their reasonings actually hinder them from comprehending by faith the objects of faith: that without the peculiar grace of God, a secure, certain, and undoubting confession of infinity can never be expected from free reason; although the error here comes not from reason, but from the mode of reasoning on the infinite by comparison with things in the finite sphere.

§ III.

Assuredly pains and labor are needed to enable us to convince the mind when in error. Thus, if we hear any one speaking philosophically, as above described, we cannot possibly acquiesce in all he says, or be silent before his arguments. On the contrary, we are bound to talk with him, to take up his discourse, and to convince or vanquish him by reason. Without the assistance of reason, it would be useless to expect success. If then, we wish to shake him in his opinion, we must use reason, and not prayers alone. We must indeed be scrupulously careful to conquer him mediately, or by the use of means; that is to say, by words, and by arguments, and in short by his own philosophy. If we leave him without using means, we shall always be in doubt whether or no he has the power to conceive the contrary and the better opinion, and whether he will not argue otherwise at another time. Duty requires us to discuss reasons by reasons, particularly in matters and points of faith, which affect the human mind so powerfully, that when once the individual is convinced of them by reason, there is nothing whatever, not even the loss of human delights, no, nor death itself, that can afterwards make him swerve from them: so greatly does the mind respect itself. To convince reason, reason must inevitably be made use of, and persist in the even tenor and series of argumentations and inductions. Were we to seek causes and reasons from any other source than reason, the mind might be turned away in a false direction, the conclusion be foreign to our aim, and the reasoning faculty be established in its errors. And as we are treating of God, the soul, the salvation of man, and his happiness after death, it is worth our while to put forth all the powers, and strain every nerve, of reason. Still it is easy to foresee, (if we persist in the same series of arguments, with the intention of searching out the infinite essence of God, and of deducing his infinity as a result of our exploration, or if we question whether the infinite be the origin and cause of nature,) it is easy, I say, to foresee, that we can never vanquish the philosopher with arguments like the above, which are in fact his own, but more likely we ourselves will fall into his maze, and be unable to find

Reason is to be used.

an outlet without undergoing another and more considerable labor.

Is there an infinite, or not? is the first question.

The essential question at present is, whether there be an infinite, or not, or whether there be a God of such a nature that he can be called infinite? This is made a question, and this therefore must in the first instance be canvassed and demonstrated by reason. Until it is settled, we have nothing to do with the other question which respects the quality or character of the Divine Essence, or its infinity, or non-infinity. The essential question is of existence first, not of character or quality. The question of AN *sit* precedes; that of QUALIS *sit* must follow. If we would enquire into the QUALITY of the infinite, (in other words, the QUALE *sit,)* we must antecedently be certain of its EXISTENCE, (or the AN *sit)*. The same applies to our enquiries into nature. If we desired to know what angels are, or the soul, or man, the question of whether they are anything at all—of whether they exist, or not,—must preface our enquiries. Although if we have attained to a knowledge of the QUALE—of the character of the thing—it will be impossible any longer to entertain the question of AN, or of its existence. In whatever mode, whether philosophically or geometrically, we attempt to explore the unknown, we are bound to certify ourselves whether the subject exists, or not, or whether a QUALITY lies in it, or the contrary. As soon as it is our fortune to be assured of its existence, we have then permission and right to enquire into its quality. Let us then be true to the series of reasons, and postponing all arguments derivable from the nature of the infinite, or the essence and quality, let us simply moot the question of existence; *i.e.* IS THERE AN INFINITE, OR IS THERE NOT?

What can be the cause of the existence of the first natural principle?

For the purpose of prosecuting our inquiry, let us accept the very conclusion with which reason presents us, viz., that naturally, or in nature, the infinite is impossible; that that which is the first or least of things, is a natural something, or similar to a natural; the infinite being as nothing in proportion. Granting then a first or least natural something, or any analogue thereof, the question occurs, WHENCE, and BY VIRTUE OF WHAT CAUSE could such an entity exist? This of itself incites our reason to e deavor to ascertain its cause. If we suppose that it existed from itself, or was its own cause, we at once have a consequence which is flatly repugnant to reason. If it be finite, if natural, or if similar to a finite or natural, that which is finite in it, or which is natural, or analogous to natural, must have a cause or origin. If it admits in it aught that is similar to the finite, whence comes this similar? How can it admit anything in it without a cause? Thus the philosopher straightway sees that his mind is toiled anew in the old difficulty; and he finds that he now doubts what he had before concluded on the ground of his own reason respecting the origin of nature. For he wishes at all events to give a competent answer to the question of the source and cause, whereby this first natural could exist, and exist in the manner that it does. Reason dictates clearly, that it could not originate itself, because it is finite, or similar to finite, and must in the first instance be finited, or made similar to the finite. The philosopher therefore now revolves in his mind whether it can exist from itself: he affirms, denies, doubts; he sees that it cannot be, but that there must have been a cause for it. If it did exist from itself, it could not even do this by accident; because one sees, that where no cause is present, neither is any case or accident: casualty itself demands not a simple or single but a multiple causation. Furthermore, if the natural primitive arose by accident, and were such as accident could make it, how could all its derivatives and subsequent issues be of such distinguished harmony, that not only the elements, worlds and planets, but the vast and beautiful kingdoms founded upon them, should exist in an order and tenor at once so stupendous and so delightful. Nothing of the kind could come by accident; for if it did, then all the productions subsequent upon it, would be similar to the accident, and destitute of order: in short, the supposition of accident is unsuited to the occasion. If we say that the above natural did not indeed proceed from accident, but from something remotely like it, the same *nodus*, the same inextricable difficulty still remains. WHENCE this something? If again we say, from itself; pray then whence this precise finite with its distinctive *qualities?* And here the mind again suggests, that if finite it be, there must have been a time when it was finited: therefore time must enter into the case, and origin also. If it came from itself, or by accident, why did it not come sooner; since it might as easily have arisen before as when it did? Therefore one does not see in this way either, how primitive nature could have existed from itself. The end is, that we conclude with reason, as nothing finite or similar thereto can arise without a cause, that primitive nature had a cause.

The mind is bound to acknowledge the infinite, as an answer to the question of cause.

If then primitive nature existed from a cause, the cause could not be finite, either in itself, or in its origin; for if it were, *it* also would desiderate a cause, to finite it. We conclude therefore again with reason, that the infinite is the cause of the finite, albeit we do not know the nature or *quale* of the infinite. Thus, though we are so far ignorant, yet are we bound to acknowledge the infinite as a cause; and consequently to acknowledge the first and least natural entity as a causate. Thus by the question of WHENCE, of cause, or of UNDE, we may be brought to a confession of the infinite, but not by the question of QUALITY, distinctive nature, or QUALE.

— In answer to the question of the cause of the least or first principle of nature.

Let us revert once more to the arguments brought forward previously, and prosecute them *seriatim,* and persistently enquire into the WHENCE of things, and we shall see that the mind and reason will answer us that all things came from the infinite. For example, if we enquire first into quantity, extension or space, in which the mind had acknowledged that there was a least dimension; and if we divide and subdivide them into lesser and least, still we shall never arrive at the first or the infinitely least portion of them; although we may think that we come at the indefinitely least. For the world cannot exist without a first principle. Therefore this least extension or quantity must be either the least of nature, or like the least, or else the simple. If we press onwards (and onwards we are forced to go, since we perceive that nothing can exist from itself, but that all things have causes), we endeavor of necessity to proceed in mind from the finite to something that can be called indefinite; nor can we rest in the indefinite, and make an end there without reference to a cause, or suppose the indefinite the first cause. On the contrary, we are forced to terminate our view wit being that involves no quantity, no extension, and no relation to quantity or extension; no relations or proportions whatever, no likeness, *i.e.* no finite; in short, a being identical with THE INFINITE. If we would pass from this primitive or simple to the first mode or motion, it must either be simple or pure, or merely an effort or internal state tending to motion. But whence? Granting that it is a state or conatus to motion, it again cannot originate itself, but must certainly have its source from something else: if from another finite, then whence its motion, effort, or state? As there is finiteness in its motion, so there is the same, or something similar to motion, in the effort or the internal tendency to motion. Thus ultimately by this way also we arrive at the infinite, and are enabled to make confession thereof.

Whence the infinite?

Seeing then that the cause of the Simple, by the joint confession of reason and the soul, is not otherwise derivable than immediately from the infinite, our philosopher may choose to persist in asking for the cause of the infinite itself. The answer to this from his own reason, as from the lips of Themis, or from behind the veil of the Temple, is to the effect that the infinite cannot possibly admit of a foreign cause, but must have its cause in itself, or be the cause of itself. Every finite must be finited by a cause. The indefinite is only so called in relation to the finite; and has a *quale* or distinctive nature that obtains its very distinctness by a cause, or from some other being. But what is infinite, cannot be finited or rendered finite: it cannot be made to have a distinctive quality, it cannot be affected in one way or another, or in one time or another, because it is not finitable, or finite, but infinite. Prior and posterior, great and small, are not to be predicated of the one infinite. As then it cannot be finited, so, being infinite, it is involved in its own cause.

When did the infinite originate?

And if again it be asked, When the Infinite originated? the same answer must be given, viz., that the infinite is infinite in point of time also. If infinite in one thing, it cannot be finite in another. In time, as well as in space and extension, there is a greatest and a least; in time, as well as in motion or celerity, there are succession, degrees, and moments. Indeed, finites cannot be called finite unless under the relations of time and succession. Of the pure simple, as not being finite, neither time nor succession can be predicated; but with respect to origin it is regarded as instantaneous; yet still not eternal, but in a manner, before time. And as the infinite has no cause in anything, so it can have no origin in anything; for origin involves cause, as being in relation to time considered as finited by moments: and as the infinite is the cause of itself, or more adequately speaking, is *in* the cause of itself, so also it is *in* the origin of itself. In a word, where there is no substantial or finite, there is no mode, motion or celerity: where there is no celerity, there are no degrees and moments, and consequently no time. The infinite is therefore identical with the eternal, and is in truth eternal in all time; time being only a peculiar relation of the finite sphere; whence nothing past, future, or successive can be predicated of the infinite, in which all is present and sempiternal, both with respect to the past and the future.

By this line of reasoning I think that the human mind acknowledges God as infinite, and as the cause of the finite, and consequently of nature; and that it no longer rests in the primitive substance of nature, so as to make God and primitive nature one and the same; or to attribute all things to nature; but, on the contrary, sees that all are due to the Infinite, or in other words, to God.

§ IV.

Having thus at last attained to confession of the infinite, so that, *nolens volens*, reason is obliged to admit a something that is utterly unknown, and can never be resolved by the known, a being who is properly termed Infinite,—let us now take this confession and tacit admission, and proceed onwards, and see whether we can, by reason, attain to a still more distinct acknowledgment, that there is an infinite, or that God is infinite, and that God is the author and producer of nature. Reasoning *a priori* we have found in the foregoing pages that this unknown being exists, or that there is an infinite: we will now enquire experimentally whether the same conclusion becomes irresistible when we reason *a posteriori*.

What is the distinctive quale *of the primitive entity of nature?*

Let us confine our attention still to the first and smallest natural principle, so that we may not disturb the worshipers of nature in their circles and spheres, but may keep them constantly attentive to their own principles, and allow no foreign considerations to interfere between their minds and the conclusion. It is granted then that the least natural entity derived its origin from the infinite, for we have already seen that no other origin of it was possible: the question now is, What are the distinctive qualities of this least natural or primitive entity? Is it the first seed of nature? Does it involve any natural predicate, like what we find in nature? Or is it only an analogue or simile of the substances, essentials, attributes, modes, &c., that we observe in nature? Here I will answer agreeably and in conformity to the principles of those I am reasoning with, that it has in it every primitive quality that there is in nature, and every simple also; that consequently it is the seed of all natural things; that it is their principle; that it is that out of which, by degrees and moments, ultimate nature is unfolded: in a word, that there is in it, as primitive entity, everything whatever that we can possibly conceive as existing in nature; and that thus in this prime, or in an indefinite number of these primes or leasts, nature exists in her very seed; out of which, whether considered as one or many, she ultimately issues forth in all her diversity, in all her manifoldness, with all her distinct and abundant series, mighty in the heavens, in the worlds, in the planets, in the kingdoms of each peculiar planet, elemental, mineral, vegetable, in the parts of all these kingdoms, and in the parts of the parts; in short, with whatever can be predicated of her as nature, in her least or her greatest sphere. But as to what the *Simple* seems to have been, we have treated of this subject at some length in our *Principia*,* in the Chapter on the Elements.

Be it then according to the opinion of those who hold that all things issued in natural order from the first entity, simple, seed, least, or primitive. I am now anxious not to disturb them in their new-born acknowledgment of infinity and God, and therefore I shall not attribute anything to God immediately that they themselves think, or can think, should in right reason be attributed to nature. For I am willing to make concessions, in order to secure a kindlier and more cordial unanimity between us in our arguments. (Nor is there any harm in taking their side of the question, inasmuch as they now acknowledge nature to be not the first cause of the world, but the second, and the second cause to be not self-active, save in so far as it has received, and perpetually receives, its activity from the first cause, that is, from the Infinite.) Moreover they now grant that nature was produced by the Infinite, or God, for they acknowledge it as a causate, and the Infinite as a cause. Let us then see whether the Infinite may not be still better acknowledged from this ground, namely, if we concede these points; and whether it does not necessarily follow, and indeed shine forth with fresh distinctness, that nature cannot be its own cause, but that the Infinite is the cause of nature.

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* *The Principia; or, the First Principles of Natural Things, being new Attempts toward a Philosophical Explanation of the Elementary World. (Translated from the Latin by the* Rev. Augustus Clissold, M.A., 2 *Vols. 8vo., London.* 1846; *and published by the* Swedenborg Association).—*(Tr.)*

We grant that all things issued naturally from this primitive entity.

Let it be granted then that all things whatever in both the visible and invisible worlds are derived from the least natural primitives; moreover that they issued successively therefrom by a natural, mechanical, geometrical, physical, or any other necessity you please. What is the consequence? Plainly this: that in these primitives lay the peculiar nature and power to produce all things thus by natural necessity; and that all things inhered in this power or nature, either as analogues, or as causes; under which forms they would be similar to their natural effects, both in attributes, essence and modes. In whatever numbers and of whatever character they may be conceived to exist, either philosophically or rationally, still it will follow, that a power, aptitude and faculty of producing all things, as ultimately they were produced, lay in them. I am unwilling to deny the principles of those I am reasoning with; for by no possibility can I frame so many details in this involution of causes in primitives, as I am ready and willing to grant: for the more I grant, the more surely my reader must acknowledge the conclusion.

Let us now repeat our first deduction, viz., that the infinite is the cause of the first or least finite. On this point we are already agreed. Then I just now granted that the whole wo

In the primitives lay the quality of producing the consequences.

including its series, appendages, and parts, came forth in natural order, and by any necessities you please, from the same least and primary finite. What is the result but this, that the quality of producing these consequents lay in the primitives or leasts? For nothing can be produced from a seed, unless the seed contain an aptitude for, and a quality of, producing it, or developing itself. And though this quality may seem to exist in the sequences or derivatives as well, yet still they must have received their share of it from their first principle; shewing therefore that in the latter lay cause, and quality, and the whole scope and power of the primitive. Let us then consider it certain that there was in it everything whatever, be its characteristics what they may, that one can naturally dream of or imagine. Now comes the question, WHENCE all this in the primitive entity? It is no longer denied that it derived its origin from the infinite; and that its origin was answerable to its distinctive nature. It follows therefore that all that one can suppose to have lain in the state of primitive entity in the first principle, derived its origin from the infinite,—from God who alone is infinite.

We admire all natural things in their cause.

We will here illustrate the foregoing subject by a few comparative instances. We see that man has numerous members, numerous senses, and a large faculty of reasoning; also numerous internal parts. If we fix upon any of the parts, as for instance the cerebrum, it again has numerous parts of its own, both membranes, substances, nerves, marrows, and other appendages, besides fluids. And the rest of the body the same. When we examine its parts, we find them severally furnished with manifold arteries, fibres, tendons and tunics, and possessing a fine mechanical adaptation for every movement they are intended to perform. If we consider the parts one by one, in every nerve we see numbers of membranes, numbers of branches, and infinite details; and if we take any part of these again, we find numbers of vessels of different classes; and the same if we take parts of parts, and repeat the observation. Then if we choose to exalt our vision by the microscope, how much more still shall we bring to light! Yet all these objects and details have arisen out of one seed,—out of one primitive substance. If therefore we now direct our attention to the human body, and its parts, and their parts, and at the same time to its first substance in the ovum, and submit both to the operation of the mind, we shall in that case more greatly wonder at the ovum, least, or natural primitive of the body, than at the body itself. The greater case of admiration puts out the lesser. What we wonder at on a great scale, in large objects, we wonder at still more as able to exist on the minutest scale, in the least of things. Admiration and astonishment are concentrated on that least sphere, wondering how it could involve the power to produce the whole system; and such a system! When we say that in this least lies the cause of the whole, we are struck with admiration of the cause. If I say that this has its cause, admiration rises to higher powers in contemplating that cause. If I say that this lay in that least first principle, and not this alone, but an indefinite number of similar things, and of other things besides, then our amazement is increased almost to infinity; and we ask ourselves how such a power, or anything like it, could lie in the primitive, as to enable the whole to exist as it does with all its distinctness. The closing wonder is felt when we declare that the first cause of this distinct least principle lies in the infinite. Then if the mind were capable of the state, it would be infinitely wrapt in amazement, at finding that in the least first principle there lay a distinct ground and cause for the production of so grand a result or system. Did we choose at the same time to consider other individual objects of nature, which exist in indefinite number in the visible world, we should but see the same fact, and be presented by every object with the same conclusion; to wit, that in the first entity or principle we must wonder at the infinite most; and that that which is visible, allures us to admire it in the first instance, because it plays before our senses; but that afterwards it leads us onwards to a greater admiration of its origin or cause, not merely as a cause, but as involving in its single self a power of producing modification in all its derivatives: and that ultimately it forces us to sheer astonishment at the quality in the first principle: and as wonder cannot possibly end there, so it must end of necessity in the very first cause, that is, in the Infinite, in whom lies all that we wonder at; in whom we wonder at the Infinite only, and by no means at the natural on its own account, but in its cause. In instruments and machines, such as clocks or watches of exquisite and elaborate workmanship, we admire the motion, the wheels, and the fine mechanism, yet these are not objects of wonder, since wheels, powers and mechanism are familiar to us: what we really though unconsciously wonder at is the first cause; not the first cause considered as organic or mechanical, for this may be of the simplest construction; but the cause in the person of the inventor; and not the inventor as he who made, but as he who invented; that is, foresaw that this consequence would flow from that; and that an instrument of such a make would produce such or such an effect, and no other.

Was all nature once in these leasts?

We will now admit further, that all things proceeded in natural order from these least first principles to the greatest effects, in series, by causes, by necessity of causes, by motions manifold in derivation, and by the powers and forces of the same. Still it follows, that the characterizing power of this distinct procession, lay in the first principle or least entity, and that this least obtained it from its own cause, that is, from the infinite. The more then we choose to send the mind abroad over the details of the subject and the series; the more we wonder at in nature; the more we heap causes upon causes; the more we multiply, divide, and reckon up motive powers; the more must we wonder at the first and the least of nature, and the more at the Infinite, its cause. Amazement cannot stop short in the causate, or end but in the cause; nor in the cause, as a cause, but as an infinitely intelligent cause: in this it must necessarily increase to the dimensions of the cause, in short, it must become as infinite as its object.

The greater worshipers of nature we are, the greater worshipers of Deity we may become.

It may now be concluded, that the more highly we think of nature, the more we attribute to it, the more we worship it, the more we explore and wonder at it; and the more numerous the causes, mechanical, geometrical, and natural, that we make necessary, the more must we wonder at the Infinite, who is the cause of all things. For the greater adorers and worshipers of nature we are, the more we go back to the causes and primitives of nature; the more also we come to simple principles, and the more we acknowledge that all the others originated successively from the natural primitive; and the more again we are led to wonder at the state of this natural primitive; and how all things that we see, and can possibly imagine, nay, how not only mechanical but even physical causes themselves, can have lain involved in it. I am anxious therefore that the reasoner should centre all his admiration in that first or least principle with which he supplies me; for by this means will it not all end in the cause of that principle? that is, in the infinite, as having produced the principle? Therefore in proportion as we worship nature, and believe in her as the origin of natural things, in the same proportion we may become worshipers of the Deity; because, out of the entirely perfect succession of things, modes, causes, contingents, we may experience deeper wonder over primitives, than others can do in contemplating the whole field of derivatives.

From the perfection of the primitive. Moreover in the philosophical primitive or least, or in the simple principle of nature, we may in a measure contemplate infinity in another way; we mean, by regarding the perfection of the primitive. For if it be so perfect as to result in the production, by multitudinous causes, necessities, motive powers, and all-pervading series, of the entire universe,—of a universe, in which there is no part but conspires most perfectly from one end to the other, through an unbroken chain of means,—can we not contemplate infinity in this; or at any rate an attribution that we are unable to conceive analogically or finitely, and yet which must have been present in a manner in the primitive; in short, a superlative perfection of nature which can come from the infinite alone. In this way then again we must acknowledge the infinite.

§ V.

Were there contingencies in the primitive? Before the world could have attained its present completeness and desirable beauty, before all series could have arrived so harmonically at the actual end; innumerable contingencies, and contingencies of contingencies must have been present, and innumerable modes and modifications also. Granting that all things proceeded with the greatest unanimity, by mechanical and physical necessity, from the least first principles, to the ultimate compounds of the world,—though I am unwilling yet to state that it was so, before it is proved by arguments and reasons,—but granting it for the present; it follows, that nature could not cause contingencies, and give causes to causes, so that all things should conspire and proceed in combination in the wonderful manner that they do, to a single end, unless the essential and absolute cause were present in the primitive entity, and by its derivation through a succession of compounds, completed the world in a continuous chain in one distinctive manner. If then the contingencies also were in the primitive entity, it follows as a matter of course, that that could be nothing less than infinite wisdom from which only the most perfect principles and order immediately proceeded. It follows also, that in this way, all things that as regards time were future, were present, and intrinsically existent in act, in the primitive entity. It follows also, that we have an indefinite perfection to consider in the primitive; and that the existence of the infinite takes new plainness from this ground. Nor does this seem to be so far from the truth as perhaps on a first consideration might appear. For it is not denied that all things were present with God at the beginning of creation; or that he foresaw all things, and at once exerted his providence in all things; and consequently formed them in such wise as to tend spontaneously to the truest end. What God produced immediately could not fail to be superlatively perfect. Consequently nothing but what was equally perfect could lie in the first principle; for nothing of imperfection can issue from the infinite. If then it were the very pinnacle of possible perfection, all things must have existed in it in potency that would ever exist from it in act; which leads to the further inference, that all the causes also, physical as well as mechanical, that were destined in succession to perfect the world, must have existed by implication in the same. These premises, however, by no means involve fatalism in the series of nature: or that God is remotely the cause of imperfection, which began to exist, in the world and in man, by reason of the existence of evil. Imperfection, as the result of evil, must have its cause in the finite, and not in the infinite. If the primitive, as it arose immediately

[God is not the cause of imperfection].

from the infinite, were superlatively perfect, and the other derivative existences were less and less so, it is a plain proof, that the latter had their origin from finites successively and immediately, which would account for a successive or graduated series of imperfections. It is a proof, moreover, that in the origin of these other things which are comparatively imperfect, there was more and more of the natural principle involved,—more and more of that which was divine only mediately, or after the intervention of nature. Nature, then, or the finite, and not the infinite, is the cause of all imperfection.

Nevertheless all things are from God.

Furthermore it may be argued with good reason, that all things whatever, whether compound or simple, the whole or the parts, the heavens or the worlds, were created and produced by God alone, and not by nature. To nature nothing can be attributed, because all things are so made as to conspire and proceed together, spontaneously and necessarily, from the first end, through the means, to the second or last end; that thus the cause of one thing may come from the cause directly preceding it; and all the causes be therefore centred in the first cause: so that to attribute anything to a natural cause, is the same ultimately as attributing it to the first cause, or to God alone. Nature is then but a mechanism, which is bound to keep certain sequences because the first cause has so willed, or what amounts to the same thing, because He so wills now. Therefore all that there is in the world is the work of God, and none of it is the work of nature. So likewise whatever we wonder at in nature—whatever we think wise, exact, harmonic, whether below or above our senses—we wonder at, not as natural, but as divine. There is nothing natural but is divine; and so in every portion of the world, to whatever corner we turn our eyes, there is nothing existing wherein we ought not to wonder at the Creator and the cause. Hence it follows, that the more we wonder at nature's play, the more do we wonder at the infinite in nature: because the natural is nothing but obedience; and not even obedience, inasmuch as nature is forced by necessity to obey.

We may attribute [causation] to nature.

Since then there is nothing natural that we can wonder at, still less worship, on its own account, but only as divine, we may now, acknowledging this, nominally attribute to nature, or make use of her name, although nature is not the infinite, but the finite. Much in the same manner as when we frame an artificial machine with our hands and fingers; after which, we have a right to call it a machine, and to say that force or power resides in it; in which case, although the force is now in the machine, yet we do not wonder at the machine, but at him who made it. For it was put together by the hands and fingers, and in this way may be called their work; and so we wonder at the maker's hand as the real machine: though even this improperly; for the hand cannot claim to be more a machine, or to have more the force of one, than as it was the means or instrument of construction. We may therefore go further, and declare that the ultimate machine was the work of the human body, and so wonder at the workman in a gross sense; but even then the object is not worth the wonder, because, in so far as the machine was the work of the hand, it was already the work of the body. We may then again extend our inferences, to the consideration that the machine was the work of this or that individual; and further, to the conclusion, that it was the work of man considered exclusively as a rational being, and therefore the produce of his imagination and scientific skill. Nor is even this true, unless we add, that it was the work of his soul too, that is to say, in so far as it is a work of reason, by whose instrumentality it was invented, and indeed by whose command it was ultimately constructed. And in the work therefore we admire the wisdom and intellect of the inventor, but not the actual machine, except for its abstract mechanism; nor do we admire the hand, the body, or any of the other instruments whose obedience to the soul is a mere matter of necessity.

To lead us then to acknowledge in the work and machine the Builder and the Infinite, and to see not only his greatness, but his infinity, and that nature and the finite can have no claim to be more than means or instruments, which are bound by necessity to do what they do:—to lead us demonstrably to this issue, there are no better arguments than are furnished by the contemplation of His very works themselves. For the objects of nature touch the senses, which ultimately move the soul, and mediately create a profound astonishment; which cannot so livelily be done by reasons, without the survey and contemplation of some actual work of which the whole, as well as the parts, are brought before the mind.

By the contemplation of nature, we are led to an acknowledgment of God.

By the heavens.

Having premised so much, let us turn our eyes to the heavens, and contemplate the universe. How wonderful to us are the heavens! filled with stars innumerable! enriched perhaps with innumerable worlds like our own! their very vastness in our conception, sufficiently wonderful! although it is probably little that we see, and all of it not a point to the Infinite. If we regard the stars as so many suns, each having its planets about it, and forming with them a separate world* or mundane system; then what a ground of wonder we have in the multitude of worlds! What a special wonder in the indefinitely finite! And if we continue and extend the contemplation, we find that a world, a single world, which appears so boundlessly vast to us, is but one and a small part of the universe. If we consider the parts, stars, or suns, or the worlds, severally, we find them unitedly constitute one system, which cannot subsist without the parts. Perchance every part is so necessary to the system, that it could not be absent without breaking a link in the chain. If we use our eyes and minds together in no greater field than our own world, small as it is in relation to the universe, how innumerable are the objects that greet us! that move our amazement! The sun, a planet, a satellite, our own specific earth, any part of any one of them, would more than exhaust our space and time. Nay, there is not a part but is necessary to the rest as well as to the whole, and all together constitute a system with the parts so harmoniously combined, that there is nothing therein that could be absent with impunity; nothing but has its peculiar use, both for the subsistence of the other parts, and for the perfection of the whole: to realize which, in anticipation of the end, indefinite series and causes were required, mechanical as well as physical or contingent, and coexistent as well as successive. If these things were as perfect at once in the first momentum and potency as they are perfect now in act and fact,—if all things were present in the first entities,—what wonder should not overcome us in considering the causes of the whole and of the parts.

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* By a world, *mundus*, Swedenborg means a sun with its planets, or a single solar system.—*(Tr.)*

By the structure of the human body. As we are upon this subject, we will also contemplate the structure of the human body, and shew therefrom, that there is nothing throughout it but is necessary to the parts and the whole, or but is of use to the subsistence of the whole: likewise that all things therein conspire to a common end. But can nature by itself produce such a combination of parts? Can any machinery without an infinite intelligence? Without a cause in God? Without a Providence most wise, reigning in contingent, physical, and mechanical causes; which, had they not conspired in the wisest manner, could never by possibility have originally come together of themselves or by accident? But as we are about to treat specifically on these subjects in our Theory of the Intercourse between the Soul and the Body, we will here confine ourselves to a general account of the use which the several parts appear to perform for the whole.

Man, as we all know well, was created to enjoy the delights of the world, and to possess the earth for himself and his posterity. Wisdom and reason were given him, to venerate and worship the infinite Deity, that he might better make use of worldly delights, and have a finer or more delicious sense of them, to lead him to associate them with heavenly: also to carry the world to a new perfection, which it could not attain without a material being and human means; lastly, to commence a life and existence which should thenceforth be sempiternal and immortal, that he might increase the number of the angels. And that man might accomplish these ends, a body was given him, and parts and members were added to the body, all conspiring to the same end: a head was given him, with a brain therein, and this brain endowed with senses, and the senses with a soul.

Passing the bones of the skull,* (which are meant to defend and preserve the machinery of the brain,) and passing also the coverings or integuments of the bones, namely, the cuticle, cutis, pericranium and hair; let us proceed at once to the inner parts. And here the first structure that occurs is the dura mater, a membrane consisting of tendinous fibres, lining the skull, and united to it in numerous places; whereby it defends the underlying membranes and the substance of the cerebrum; strengthens both the brains, maintains their figure, and preserves their respective boundaries; so that all the parts are kept immoveably in the genuine and natural position, and the cerebrum is not injured by immediate contact with the bones; besides which, this membrane serves as a means to bring certain sensations inwards [to the soul]. Underneath it lies the pia mater, between which and the dura mater, according to some anatomists, there is a third membrane, viz., the arachnoid: but for the present let us keep to the pia mater, which dips down deep into the cerebrum, and besides investing its parts, also sheathes the spinal marrow and the nerves. This membrane is beset with innumerable blood-vessels, seeming to consist of hardly anything else. The end or purpose of it is, not only to envelop the cerebrum, but also to invest its intimate convolutions and folds; to distribute blood to it; partly to bring heat, partly to supply liquid, for nourishing, irrigating, and giving substance and combination to the parts: also not only to receive a fine sense, but to derive it inwards along the subtler membranes, that those which are subtler still may be able to receive the tremble of the delicate sensations; which exquisite membranes are brought into communication with all sorts of nerves by the pia mater; for the latter invests these nerves, and is their grand constituent, because it is their common covering.*

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* The *anatomical* particulars in this work are taken almost word for word from Heister's *Compendium Anatomicum*, to which reference has been made by the Translator, for the purpose of correcting numerous errors, and of supplying what was *necessary to complete* the sense.—*(Tr.)*

We pass over the division of the cerebrum into hemispheres, and of the hemispheres into lobes, also the division of the brain into cerebrum and cerebellum, and into cortical or cineritious and medullary substances; each of which subdivisions, both generically and specifically, has its own particular use in conveying more and more inwards not only the rude sensations of the body, but the sensations of all the senses, till they arrive at the very soul or subtlest parts; likewise in nourishing, and keeping in their places, the neighboring and the hard parts; of all which not only the parts, but their parts again, contribute all their endowments to ensure the nourishment, subsistence, action and passion of the general system; in a word, to enable man to live, to feel; and so to live and feel, that his subtlest part shall live in a sense above all others. And in order that all things may tend to this end, there are, besides other provisions, certain remarkable cavities in the cerebrum, two of which are in front; and when these are exposed by the knife, other parts again come in view, as the septum lucidum, a transparent partition of medullary substance covered with pia mater, and dividing the above cavities or ventricles from each other. Also the fornix [under the septum lucidum], likewise composed of medullary substance. The choroid plexus, a membrane replete with blood-vessels. The corpora striata, two bodies [cineritious on the outside, and] through which the cortical or cineritious substances run in stripes and rays from one end to the other, to enter and originate the noblest of the marrows, *i.e.* the medulla oblongata, which is the source of nerves of all descriptions. The thalami nervorum opticorum, a pair of bodies, white [on the outside], and cineritious [internally]. On opening the third ventricle again, we find several parts deserving of notice; as the pineal gland, the nates, the testes, under these the great valve of the brain, and [the aqueduct of Sylvius], at the posterior orifice of the latter, the anus, and the iter ad infundibulum, through which all the four ventricles communicate with each other. We will not now dwell upon the fourth ventricle, which is situated between the cerebellum and the medulla oblongata, but will content ourselves with observing, that all these organs minister to keeping the parts of the cerebrum in the most distinct order of mutual subdivision, so that each is not only nourished, but enjoys communion with its fellows, and what is of main importance, superfluous matters are excreted from it, and prevented from embarrassing its functions.*

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* Respecting the integuments of the cranium, and the dura mater, arachnoid membrane and pia mater, see Heister, *Op. Cit.*, n. 266—269.—(Tr.)

We now come to the cerebellum, which is separate from the cerebrum, and only one-sixth its size, and lies in the occipital region, to be nearer to the involuntary actions of the body, and consequently nearer to the heart and lungs. The cerebellum claims our especial regard for its singular lamellated composition of parallel and circular portions, which terminate in the vermiform processes, anterior and posterior. It is composed, however, of the same cortical and medullary substances as the cerebrum, although these constituents are varied in their proportions in the cerebellum, and their relative situation is different. The spectator may also justly be amazed when he views its lobules separately, and contemplates the position of the medullary portions in their interior; likewise when he sees the peduncles of the cerebellum, one of which forms the great valve of the brain; a second, the annular protuberance [of Willis, or the pons Varolii], while the third descends to the medulla of the nerves, or as it is commonly termed, the spinal marrow. And his amazement may be the more when he considers, that whatever is effected in the body by the ministration of the cerebellum, its near neighbor the cerebrum knows hardly anything about; and yet that the cerebellum knows all that the cerebrum does. For which reason, whatever the former accomplishes in the body, is termed involuntary, implying that there was no antecedent perception of the object before it was realized in act. We have instances of this in the motion of the heart, in that of several muscles and nerves in the body, as well as in innumerable other effects.*

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* Respecting this paragraph see Heister, *Op. Cit.*, n. 270.—*(Tr.)*

But let us revert to the cerebrum, and note the medulla oblongata. This arises from the corpora striata, and running back towards the occiput, joins in contiguous relations with the medulla spinalis, whereby it becomes the common parent and nurse of all the nerves wheresoever situate in the body; likewise of all the nerves of the senses; that is to say, of sight, hearing, taste, and smell; on which account indeed all the sensorial nerves enter it and end in it. Moreover it is of medullary substance externally, and contains [some little] cortical [or cinefitious] substance within, in which respects it is the inverse of other parts in the cerebrum.† But how all the sensations, and likewise all the ideas and operations of the soul, are concentrated in this organ, and how it is the fountain-head of all the senses, however fine or gross,—these are points that we have to shew in another place. And as the spinal marrow is connected by contiguity to the medulla oblongata, we have also to consider how the former runs down the back in the bony canal formed by the vertebræ; how it is invested by tunics and membranes; how it has communication within and without with those of the cerebrum; whereby whatever is done in the body is at once conveyed to the cerebrum, and by it felt, and then referred to the soul, and expanded into will. And as the spinal marrow performs this grand office for the body, it is protected by a chine of bones consisting of twenty-four vertebræ [and the sacrum]; by a most robust ligamentary membrane, which binds the vertebræ together; by the dura mater, the arachnoid membrane, and the pia mater, which follows the nerves through all their subdivisions: and it sends forth transversely into the body, for the performance of various functions, from thirty to thirty-two pairs of nerves, which thereafter split into branches and twigs the most diverse, and are ultimately expended in exquisitely small corpuscules of lamellar structure, or else in the tunics of the body.*

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* Respecting the cerebellum, see *Op. Cit.*, n. 271.—*(Tr.)*

† Respecting the medulla oblongata, see *Ibid.*, n. 272.—(Tr.)

Let us also briefly review the points in the anatomy of the eye,† and see the wonders of nature working in combination with a thousand parts, for the single end of producing sight. We will here say little of the eyelids, eyelashes, palpebral muscles, sebaceous glands, caruncula lacrymalis, membrana semilunaris, puncta lacrymalia, lacrymal gland, [the muscles of the eyes], the fat, and many other parts, which contribute to the motion, nutrition and support of the organ, and hold and keep it *in situ*, to ensure the uninterrupted performance of its functions. In dwelling, however, on the other point, viz., the mechanism of vision or the sense of sight, and not of its instrument, the eye, we have to consider the various tunics of the eye; the tunica albuginea or adnata, which is freely supplied with vessels; the transparent cornea, which is [convex, and] divisible into various layers; the sclerotica, which is a hard and opaque coat, extending from the cornea to the optic nerve; the choroid coat, which abounds in distinct vessels, and is black in color; the uvea, or anterior portion of the choroid, which may be seen through the cornea, is of a convex shape, and presents again several points for observation; as for example, an anterior colored surface, named the iris; also the pupil situated nearly in the middle of the iris, and which admits of contraction and dilatation: again, the posterior surface, black; on which, when the black portion is cleared away, we see the sphincter of the pupil, the ciliary fibres or processes, and the ciliary ligament, the circulus arteriosus and venosus; and certain black lines running between the ciliary processes and the ciliary ligament. Then we have the retina, a very delicate, glistening tunic, of a peculiar mucous texture, whither in the first instance all vision, or all the organs of vision, centre or tend, thither inclining and conveying the rays, which are afterwards carried on by the optic nerve towards the anterior and inner parts of the cerebrum; the retina seeming to be the receiving chamber for the rays, as being the expansion of the optic nerve. In all these details we perceive a peculiar mechanism, analogous to that of the motions in the particles of ether; and an admirable harmony of all the parts, whereby the several motions received are variously concentrated in, or conveyed to, the retina, which expands upon the optic nerves, that in their turn run through the cerebrum towards the medulla oblongata, and plunge thereinto, in consequence of which the remaining stages of the progress lie beyond our senses. And in order that the eye, as an organ, and the parts of the eye, may maintain the natural and mechanical position that will constantly fit them for receiving the modulations of the ether, humors or liquids are supplied which provide for the expansion of the tunics, and at the same time are pervious to the rays, and in no way hinder the transmission of light. Thus we have the aqueous or albugineous humor, in which the uvea floats freely; also vessels by which this humor is continually renewed, and provided in just quantity and of proper quality. Then there is the vitreous humor, extremely pellucid, filling the posterior portion of the eye as far as the retina, to which it is contiguous throughout on the back part; and without which the retina would get too dry, and neither be duly expanded, nor have any power of receiving the motions that are passing inwards. Furthermore, there is the crystalline humor or lens, of a denser structure than the other humors, and enclosed by a tunic within a depression in the vitreous humor; this lens is suspended freely [by the ciliary ligament] between the aqueous and vitreous humors, [just behind the pupil]; its mobility being thus secured; and it is composed of a number of pellucid, vascular lamellæ, [after the manner of an onion with its skins]. The crystalline and vitreous substances are surrounded by a fine vascular tunic, which by enclosing the lens in the bosom of the vitreous humor, tends to protect and preserve it. We shall not now dwell upon the minute arteries and veins that enter into the organization of the eye in so wonderful a manner; or upon the nerves; as for instance the optics, which running back from the retina plunge into the medulla oblongata; and those other nerves whose office it is to preside over the motions of the whole organ, both in general, and in particular; or upon the muscles. The result of our considerations is, that we now see how all the parts one by one conspire to make the whole, *i.e.* the eye, a fit organ and instrument for receiving the modifications of ether or light, and a means of sensation; which exists not at all in the eye, but in the cerebrum, and in those little membranes where the true representation of the object takes place; of all which subjects we shall treat in detail on another occasion. The eye of itself is an organ destitute of sense, for sense consists in the inner parts; in the other end; that is to say, above all, in the soul.

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* Respecting the spinal marrow, see *Op. Cit.*, n. 274.—*(Tr.)*

† Respecting the eye, see *Ibid.*, n. 276.—*(Tr.)*

But let us confine our attention to a single organ; for there is not an organ in the animal body but if examined specifically and particularly will afford infinite grounds of amazement; at the manner, for example, in which one part joins with another, in which one part moves another; one part determines the shape of another; holds another in its place, preserves and nourishes it; the least in this way ministering to the greatest, the invisible to the visible; and all conspiring to one end, to enable man either to see, or hear, or enjoy some other sense; and all collectively, or the whole, to empower him to lead an *active bodily* life, and to be a rational creature; which results themselves conspire to the primary end of creation. Let us dwell then, as we before said, upon the anatomy of a single organ, which shall be the Ear, and let us see whether it alone be not sufficient to transport us with astonishment; and afterwards let us conclude what our astonishment would be if we entered upon the anatomy and examination of the remaining structures. Hearing is the principal organ or instrument of the soul; for by hearing we are educated, and taught to perceive; by hearing the sciences are formed and imprinted on the memory, after which the soul can call them forth distinctly one by one as it requires them, and make the human being rational. And this being the end, therefore the principal parts of the organ of hearing, as the semicircular canals, the cochlea, and the ossicula auditus, are nearly of the same dimension and size in the infant as in the adult, and neither grow, nor undergo adaptation and remodelling by habit and exercise, like other organs. The auricle or external ear, including the concha and meatus auditorius [externus], is so shapen, that every vibration of the air is collected from all sides, and nicely directed to the membrana tympani. Hence the auricle is cartilaginous; for were it osseous, or too hard, it would reflect the vibrations; and were it fleshy, or too soft, it would yield to, and absorb them; while as it is, it can always regain its form and position, however bent it may have been, and always assume that figure which best accommodates it for catching sounds. To ensure this result, it has two or three muscles; one lying upon the temporal muscle; a second, consisting of five or six fleshy fibres, arising from the upper and anterior part of the mastoid process, and terminating about the middle of the concha. And though these muscles are very small and not very active in man, yet they keep the ear *in situ* in a state of tension; for indeed it is not necessary that man should have the power which animals have of pricking up the ears. The human ear is kept in that position which enables it to take up and drink in most fully all vibrations, from whatever corner and direction they come, whether from above, or below, or with whatever degree of obliquity. This would be impossible if the ear were not reflected as it is, and if it did not lie back on the temporal bones, but were conical, like the ears of animals. At present we need say little of the nervous membrane of the auricle, which is immediately adherent to the cartilage, and helps to keep it in its place; or of the thin cuticle on the squamous portion, which serves as an integument to the ear in common with the rest of the body, and on account of its superior delicacy in this part is eminently adapted to receive the vibrations of the air. Nor need we dwell at any length on the blood-vessels; *i.e.* the arteries, arising from the external carotid, and the veins, from the jugular, which the ear receives both on its outer and inner parts. It may however be mentioned, that the branches of the carotid, after having supplied the face, ascend to the internal and external ear; and that corresponding veins accompany them: in consequence of which, a contiguity reigns, in respect to heat and fluid, both through the ear, and throughout the face, as well as through the inner membranes and meninges of the brain. The blood-vessels keep all the tunics warm and tense, adapted for whatever motions arise, and presently nourished, and perpetually capable of being nourished, by the blood. The external ear is insulcate, and folded upon itself, and we notice in it the pinna, or upper part, the helix and antihelix, tragus and antitragus; also the lobulus, which hangs at the bottom, and is softer than the rest of the auricle. Then we have the [scapha and] concha; to which, according to some anatomists [*i.e.* Valsalva], are to be added certain sebaceous glands or cutaneous follicles. All these parts are formed with the intention, that whatever vibration reaches the ear, may be carried distinctly towards the concha in the stream of a peculiar spiral curve, and so, by an uninterrupted succession of moments and degrees, along the meatus auditorius externus, towards the tympanum; whither all the spiral cavities and passages without exception tend. And if any superfluous accompaniment arises in the course of the vibration, it has a means of passing off between the tragus and the antitragus. Or if the sound should reach the concha immediately, and be reflected, yet even in this case, being reflected upon parts which serve as so many reverberating tongues, it will all be taken up, and conveyed mediately towards the meatus auditorius, and thus none of it will be lost; but its course will be determined by the sides of the ear, following which it will creep and skirt, and be guided to the membrana tympani by all the walls and borders of the organ. We will not now dwell upon the various points that we find in the meatus, all of which have their uses; thus the meatus is partly cartilaginous and partly osseous; its course is tortuous and oblique, in a forward direction; it is made up of as it were broken cartilages, covered with an elastic tunic; on the convex part of the membrane lining it internally, and which is continuous with the cutis, there are innumerable small yellowish glands, that secrete a cerumen of the same color, and of a bitter taste; besides which there are hairs in the meatus, and several other contrivances. Let us, however, address ourselves to the membrana tympani, which we find to be [elliptical]; not completely expanded or flat, but convex;* not placed perpendicularly, but very obliquely [inwards]; not isolated and free, but united to the malleus; not tense, but rather loose or lax, so as the better to enable it to receive articulate sounds, and transmit them onwards. The handle or manubrium of the malleus is attached to the membrana tympani from the upper border to the centre, and so governs the membrane as to capacitate and adapt it for receiving every variety of vibrations and tones; which it could not do with any distinctness unless the manubrium were affixed to it in the way of a radius or semidiameter. But by this arrangement, no tone can set the membrane vibrating anywhere but correspondently to some distance from the manubrium or radius; so that as many distances are formed in the membrane by the instrumentality of the manubrium, as there can be possible varieties in sound. On the other hand, were the membrana tympani hung in its place without this provision, without the crus of the malleus giving it relations of distinction, it would scarcely be capable of any distinct vibration at all. The membrane has also a [nervous] cord [the chorda tympani] subtending† it, whereby the soul, as the directive power, is able to tell whether or not the membrane is properly tense all round; and as soon as ever it is too lax or too tense on any side, this little cord or nerve, (after being duly educated or informed by use and exercise, and in the end spontaneously, by habit, without its possessor being aware of the fact,) advises the soul that so it is, and that a different tension is required. For this reason the malleus has two muscles; one that can twist and more or less bend round the manubrium; by which action, if the membrane is more lax or tense on one side than on the other, a slight flexure at once suffices to equalize the discrepancy. The other muscle exerts a different action upon the malleus, and raises the membrane when the tension requires to be restored below, that is to say, in the lower part of the circle. In a word, by the action of these muscles, the tympanum may be evenly tightened or relaxed in all directions, just as the delicate nervous cord gives intimation. Of the concave figure of the tympanum we need say little. Thus much, however, is obvious, namely, that all vibrations have a natural tendency to run in circles and curves, as the forms peculiarly suited to forward their dissipation. We come now to the three ossicles or little bones of the ear, viz., the malleus, incus, and stapes. The first of these, or the malleus, has its articulation, like other bones; and this, with the incus; it also has tendinous attachments to other parts, whereby it not merely obeys its own muscles, but every vibration of the membrana tympani besides. The incus in its turn is connected to the stapes by what some consider a fourth ossicle, and term the os orbiculare; this is situated at the end of the long crus of the incus; and is received in a minute depression in the head of the stapes, to which it is connected by a ligament or tendon.* The stapes has two equal crura, which are not only grooved or excavated, but naturally flexible and elastic; and leans by a circular and similarly excavated base or border on the fenestra ovalis. By this admirable arrangement, each vibration is transmitted from the membrana tympani to the fenestra ovalis: nay, such is the connexion of the little bones with each other, that in an instant the identical effect that was received by the membrane is present in the fenestra. The stapes moves with every twinkle of motion in the manubrium of the tympanum; and the flexibility of its claws or hooks nicely adapts it for setting the fenestra ovalis in corresponding motion. The cavity in the neck or head, and in the crura and borders of the stapes, whether containing air or ether, causes the vibration to be felt inwardly likewise; and in this way also the vibration admits of being communicated to the fenestra, and at almost the same instant to the labyrinth. The fenestra again is tightened, or relaxed, by these modulations, just according as the stapes is raised or depressed, which enables it to receive the vibration of the enclosed air, which is ever present in the grooves of the stapes. And by these means the vibration is transmitted in many ways from the membrana tympani to the fenestra, and all the parts conspire unanimously to promote its reception. Moreover, a peculiar muscle is attached to the stapes, to maintain them all in the proper state, and ensure their equilibrium; and this muscle has the faculty of adapting itself to the requirements of the muscles already mentioned as belonging to the malleus. In the labyrinth again we find innumerable parts well deserving our regard. Thus there are the semicircular canals, three trumpet or cornet-shaped tubes, which open by five orifices, (for two of them have a common aperture); and are filled and in a manner distended by the same elemental fluid as the labyrinth. They are lined internally with a fine membrane, which is connected in all directions to the bone.* Thus the vibration transmitted thither from the fenestra ovalis through the membranous parietes of the labyrinth, and the intermediate air, is in a moment present in each of the canals, and is fixed and commences in each case at the appropriate distance from the orifices, and creeps in both directions towards the same. Moreover, to communicate to the soul a knowledge of the progress of the vibration, nervous twigs from the portio mollis of the auditory nerve run through all the canals; and conscious of the sound articulated, as well as of the distance that it moves through, and the velocity of the motion, they carry it through the whole of the auditory nerve, until it reaches the cerebrum and medulla oblongata, and in the last instance, the soul itself. But to give still nicer articulateness to the perception of sound, the cochlea, an organ embracing the whole mechanism of harmony, is added to the other structures. [This consists of a lamina] winding in a spiral around a central nucleus or axis [called the modiolus], and which spiral gradually tapers from the base to the apex. Thus there is no possible sound but may have its proper distance or centre, from which to begin, and go on to the extremity: for an integral scale of dimensions is provided. The gradual exaltation of the sound is also secured, so that in passing from one end to the other, it is heightened in proportion as it approaches the fenestra rotunda. With this view, the canal of the cochlea is of different thickness in different parts, and very thin about the nucleus; which capacitates it for receiving all degrees of vibrations. Furthermore, it is divided from the top to the bottom by a thin bony and membranous lamella of a hard and brittle texture; and by the attachment of its membranous portion thereto from the base to the apex, it is the better enabled to vibrate, and the vibration arrives at the end with greater distinctness. For the same reasons the cochlea has an aperture leading to the vestibule, which ensures community of effect between it and the semicircular canals. And as hardly any two tones are alike, but the variety is indefinite, so the cochlea itself presents every variety, of form, thickness, calibre, and other conditions. Vibrations moreover love spiral, circular and hyperbolic curves: and hence whatever is possible in sound can find its place in this spiral organ. There are nerves also which pass through the nucleus and lamina in numberless parts, and which receive all the various sounds; for there is no sense without nerves, and no mean to sense in nerves but motion. Hence every vibration in the cochlea and its membranes, is at once correspondingly felt in the nerves, which for this reason are spread over the inside of this organ in so many different situations. And every motion is the more sensible, since the nervous filaments traverse the cochlea longitudinally, and run towards the fenestra rotunda, near which the nerve itself enters. Which seems to indicate, that as the vibration courses along the filaments, it passes gradually from the thinner to the thicker portions, so as to be ultimately taken up and conveyed with all the distinctness possible, and with the greatest amount of sensation, by the whole auditory nerve.*

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* Heister says, *Op. Cit.*, n. 287, "Not flat, but concave." The truth, however, is, that the membrana tympani is concave towards the external ear, and convex towards the internal: see the next page, line 13.—*(Tr.)*

† Swedenborg says, "running through it," but Heister has "subtending it," which latter we have followed in the text.—*(Tr.)*

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* I have been obliged to modify this sentence, as it seems not intelligible in the original.—(*Tr.*)

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* The same remark applies to this sentence also.—(*Tr.*)

We see from the foregoing description what a peculiar mechanism of nature there is for the simple purpose of conveying inwards the vibrations of the air, and of proffering them to the soul when aught that is rational is involved in the sound; such involution being effected by the articulation and vocal expressions of speech, and the higher forms of rationality being produced or expressed by new combinations of the same. We see, I repeat, not only the mechanism itself, but all its numerous parts tending to one and the same end, to enable man to hear, to perceive the delights of this world in a reasonable manner, so as to teach him that his soul is his living part, that he may have the wisdom to mingle the delights of the world with the delights of the soul; and the delights of the soul with other delights from a purer, finer or subtler world; and at last, with God, in whom, as the one only end, all must therefore terminate. But on these subjects we shall treat more properly in a subsequent part of the work.

All parts of the body tend to their own proper ends.

If we were anxious at present to extend this subject further, we might describe all parts of the body, following up the organ of hearing with those of smell and taste, and proceeding afterwards to the heart, the lungs, and a thousand other parts, and parts of parts. For the reader will here observe that they all conspire to one end; *i.e.* the lesser parts to their end, that the larger may obtain theirs; the lesser still to theirs, and the least, to theirs: therefore all these least parts conspire through the larger and larger; in other words, they all conspire separately and jointly, to the common end, which is that of the whole. In this way there is nothing in the human body but conspires to the end for which man was created; which is, the enjoyment of worldly delights; and thereby the reference of human delights to the soul and its reason, and their unison with the delights of the soul; the making of mundane delights rational; the qualification of rational delights until they derive their essence,—their delights,—from a higher source; finally, their termination in divine delights, in which the absolute, genuine and finest sense of all delights consists; for the centre and the end of them is not included in the centre or end wherein the soul abides. Thus if delights are to be true, they can only terminate in the infinite, in doing which there is pleasure the most perfect. All the members of the body, all their parts, and parts of parts, all their very least forms, conspire, I say, to this end; all therefore tend, as means, and means to means, to no other than that total and general end for which man was created and introduced into the world.

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* The anatomical facts mentioned in this paragraph are for the most part not borrowed from Heister's work, but probably from some other anatomist. Among the author's manuscripts there are two treatises on the Ear and the Sense of Hearing; one in 29 pages folio, the other in 24. There is also a third MS. on the Ear, but which consists only of certain excerpts from J. S. Cassebohm's work, *Tractatus VI. de Aure Humana*, Halæ, 1735.

There are also two treatises on the Eye and the Sense of Sight; one in 40 pages folio, the other in 39.

For further particulars respecting all these MSS., the reader is referred to Dr. Svedbom's Memoir inserted in the *Animal Kingdom*, Vol. II., p. 653—658.—(Tr.)

Now all these provisions could not exist by accident, although they may have existed, and may exist, naturally. For we have ocular demonstration of means tending to one end; of a consent and harmony of all things and parts, and mainly of the least parts, whereby they tend in a manner to their proper centre; and we see also that they simply look on themselves as means to the common end. And could we penetrate deeper, and perceive the finer parts,—those we mean that influence the least and first constituents of the man,—conspiring to their end, we should recognize in them a still purer and more perfect aspiration to the same common end; and in the very least of all we should find the primary ground and principle of power, whereby all the parts tend thereto. In this way then we may reckon all the rest as effects and consequences conspiring to a certain end, which begins in the least or minimum, and in which, of necessity, all these things must be involved; proving that all the means reaching to the end, were concentrated, included, and consequently present in the natural minimum. We also see that the means cannot by possibility attain this end, unless causes, contingencies and necessities, innumerable and innumerable, both mechanical and physical, concurred to their combination in this distinctive manner, to the exclusion of all others.

Should the reader wish then to recognize nature as the author of the universe and of man, he will at all events agree with me, that all those things which afterwards existed in actuality, were [in potency] in the minimum itself; and this, both in order that contingencies might thus exist, and that all intermediate causes might conspire to the precise end in view. It is clear they could not conspire by accident. Accident recognizes causes, although causes apart from intelligence, whereby such combination takes place; whereby parts or causes conspire simultaneously and successively to one end; particularly where the conspiring causes are indefinite in number. To bring the matter home let us suppose that there are only a thousand causes. If chance or accident governed them all, and the whole thousand arrived at the end, and this end was of such a character, that all, in a way truly stupendous, stood related to the first and last cause, and to the Infinite,—the first and last relations of ends thereby involving somewhat of infinity;—then, I say, there would be a thousand chances; and for these thousand chances to eventuate thus, would be against all reason to suppose; that is to say, if chance be chance, and if chances arise from causes.

We will still assume the same argument, and suppose that there are chances, and also innumerable circumstances to produce them; there being therefore an adequate number of circumstances to account for the existence of all the chances. Yet review the lineage and series of chances; review their direction to a single end. Are we not forced to acknowledge here an immensity over and above them? Are we not forced to admit a directing, an applying agent,—a power by which all the elements of the series proceed from the beginning and arrive at the end in a given order? Are we not bound to admit what amounts to infinity? A somewhat whose existence and nature alike we are at once unable to understand and bound to acknowledge.

If therefore all things in nature be means to this end, and if there be mechanical and physical necessities conspiring to it, then the philosopher cannot do less than wonder at the central cause of such necessities and causes with their manifoldly successive degrees of efficiency: he cannot but see all things concentrated in his philosophical minimum; whence he may naturally conclude from real effects, by way of the senses, imagination, perception, and the soul, that there lay something in the first entity that could proceed from no other ground than a cause in the infinite. Thus by effects and the senses, and by visible or sensible nature, we are better and more clearly led to the acknowledgment of the infinite, than by the other reasons or methods of the soul. And indeed senses were given us, and a rational soul superadded to them, precisely that, in the natural state, we might be conducted sensually to an acknowledgment of deity in the infinite.

§ VI.

There is a tacit consent of human souls as to the existence of an infinite God.

We have now to shew in conclusion, that the infinite is the cause of the finite, and the infinite God, the builder of the universe. This comes in the last place, because it appeals partly on self-evidence, or springs from the human soul, and comes partly as a consequence from the arguments adduced above. There is in fact a tacit consent, or a tacit conclusion of the soul, to the being as well as to the infinity of God. This is dictated, I say, partly by the soul in its own free essence, partly by the soul as instructed and advised by the diverse innumerable effects presented in the world. Not unlike reason in the soul, which comes partly from the soul and partly from the body, although we do not know whence it comes, because we do not know the state of the soul. Nor unlike the involuntary and congenital actions that take place in the body, which proceed spontaneously without the body being aware of them; such for instance as the innumerable internal motions of the frame, of the senses, the muscles, the heart, the fluids; or such as the issue or procession of the efficient causes designed to set the muscles in motion at the will of the soul, or in obedience to predetermined conclusions. The body is indeed unaware of the ground from which these and similar actions come, and whether they are determined to motion by any cause, or none; (although the senses see that the motion exists, and perceive that it is constant;) and hence they appear to originate spontaneously, and without the participation of the body. And there are numberless other phenomena whose effects we know, but cannot explain the cause; for example, harmonies of many kinds, where natural perfection is almost attained, which arrest us at once, surprize us into praise, raise smiles of delight whenever we see or hear them; and yet of their cause we may be said to be ignorant; although they have a cause, at least in a perfection and harmony either truly natural, or that corresponds with the perfection and harmony of our individual nature. We give these illustrations simply in the way of comparison, to shew that there are many things in our own organization that we derive from a source different from either the soul or its harmonic connexion with the body; many things, therefore, which seem to happen spontaneously. And so also it may be with that tacit consent and feeling of our souls, which dictates to us the existence and infinity of God.

But it is scarcely philosophical to derive from the soul a spontaneity corresponding in character with the involuntary power in the body, or with the harmony or perfection existing in things and proportions. And yet it cannot be denied, that there is that in man as man, provided he enjoy the use of reason, which acknowledges an omnipotent God, an omnipresent and all-provident Deity; it seems therefore to be innate, and to be a power or action of reason, when not on the one hand troubled too much by its own ideas, nor on the other hand too destitute of all cultivation and development. But we care not whether it be spontaneous, or the contrary, if it be admitted, that there is no one living, provided he be not over or under rational, but acknowledges the existence of a deity, however ignorant he may be of the divine nature. Hence it is that after man has exerted his powers and whetted his reason to find out this nature, he falls into strange darkness and ideal conclusions. He knows indeed that there is a Deity; that there is an omnipotence; but he has been unsuccessful in eliciting the nature of either from any dictates of reason. Much as the philosophers themselves, who after probing the subject with unceasing perseverance, have still been unable to approach by reasonings to the *το quale* in God; and therefore they have fancied a *το quale* coincident in qualities with nature. And thus the source of error among the idolatrous vulgar is identical with its source among those philosophers who make an idol of nature: the only difference being what there is between the gross and the subtle, between the more and less plausible, between reason little developed and reason over developed.

However that we may not state for certain what is not perhaps very clearly accordant with reason and philosophy, nor prematurely take up conclusions without previous demonstration, we will for a time relinquish the point, and agree with those who declare that the acknowledgment of God is not spontaneous, but is an effect of the soul admiring the universe, or amazed at the wonders of nature; or perhaps ignorant of the source from which they spring. Still the end is the same; for still we admit a tacit consent of human souls to the existence of God. At the least this feeling and consent of our souls arises from visible nature, in which divine effects exist, wherein every part summons us to admire, and to acknowledge that it issues from an infinite fountain. From our admiration of the parts and the whole, and from our amazement at everything that sense perceives, and that reason, knowing not the cause, yet unknowing admires, the soul deduces and concludes, whether by its own action, and tacitly, or by reasoning, and not tacitly, that a divinity exists. After which it follows spontaneously, if we conclude in favor of this divine principle, that at least it has the power to bring this, as well as that, to pass; and thus worship exists.

§ VII.

Objection: Was the Divine in the primitives only, and not in the derivatives?

But here it is probable that some will interrupt our argument, by declaring that we have no right to reason about God in any such *a priori* manner, or from any principles of the kind, but that all we have to do is simply to proclaim, without any ratiocination, that God is the provider of all contingent circumstances; that now and ever he is as provident as he was at the very creation of the world; that he did not exhaust the whole of his wisdom, or spend the entire force of his providence, in his original creation; but that these remain still infinite in the provision and government of causes and worldly things according as he pleases, in conformity with what he sees ought to be;

shewing that he always expects the issue before he wills it into existence. Likewise that God is present to every contingent circumstance in succession, as at the day when the machine of the world, and the bodily machine of the soul, or the human frame, were first constructed: and that now, as ever, his state is, that at his good pleasure, he can either change, or not change, all things, agreeably to the causes and effects that he sees in operation. There are, we know, great numbers of persons who think this line of reasoning preferable, because thereby we have the divine omnipotence manifest in time, and know that at all times it will provide for human affairs, accompanying them through all their windings and changes. And especially do those appear anxious to urge this view of the subject, who cherish a finite conception of God, and cannot refrain from likening his power and will to those of some earthly potentate, who can issue his mandates either in obedience to causes and laws, or the contrary; or frame new laws at will, and impose them on human action; and afterwards either modify or reverse them. Such sentiments are peculiarly grateful to all who fancy themselves to be the near objects of regard to the Infinite, and his favored friends; and deem therefore that they can win him to their side, to work their will, and to enable them to govern human souls and societies under a pretext of divine authority.

But even this opinion is in no way contrary to mine, provided its abettors are not so gross as to think that it pleases God to be changing daily, and constantly framing new designs for every new conjuncture of circumstances; that is to say, to be continually modifying his plan at the bidding of events; so that what he would do to-day, he would not do to-morrow, because of the altered condition of things; or so that his will and decision would depend upon a succession of mutable causes, as is the case in finite man. In these respects I grant whatever can be granted with reason, if on the other hand you will grant me this,—that God is infinite. And surely you neither can nor dare deny it. If he is infinite, then all things were present to him that are future to us. For can anything be predicated of the infinite in a finite sense? Is not that then present in him which is successive or future in time? If in his infinity he has foreseen all things, has he not also provided all things? In the

Infinite, providence cannot be distinguished from previdence. If the providence followed the previdence, what would become of the infinity? If he, the Infinite, operated and provided successively and in time, with a constant substitution of new acts according to events, and if he must wait for the events before he knew what they would be, or whether they would happen, or not,—if this were the case, we again say, what would become of his infinity? If providence is successive, like time, where is the infinite? Succession itself is an implied condition of the finite? Seeing therefore that God is infinite, why should we seek to limit him by time, chance, or any other predicament whatever that would necessarily involve the existence of finiteness in his essence? If all things are realized simultaneously that will ever be realized in time, is not the infinite manifested here? If we admit that his foresight and providence are instantaneous and coincident, is not this identical with declaring that he foresaw and provided in time? In respect to us it is assuredly so; for all things appear finite and successive to those who are finite, and live in time. Therefore what happens after a finite manner, and in time, is relative to us; but is not similarly relative to the Infinite. We agree then thus far, that previdence and providence do exist; but we differ here, that in my opinion these are infinite; while according to the other opinion, somewhat of the finite is involved in the infinite. Therefore perhaps the whole discrepancy is a matter of words and not of understanding. But if there are any who think they have something to lose in the decision, because according to our principles they will not be enabled to bend the infinite to their own particular interests, or to claim from the common people that obedience which is due to God—if there are any such, it is not our intention to reason with them. It is too probable that worldly things, and not divine, are uppermost in their thoughts. Perhaps they would have the vulgar believe, that God by his own immediate agency, interposes the clouds between our eyes and the sun; that he successively rouses the tempest, sends down the rain, and paints the rainbow in the sky: that at one time he frames our members in the womb; at another, breathes the soul into the body; and so forth. Perhaps in a word they mean to teach, that God is justly represented under the image of a finite man, who would operate immediately, or by modes immediately proceeding from himself, on the grosser circumstances, and lowest parts, of the sphere of nature. And so they would see in God the proximate cause of all things. However, as all things are the effects of his divine providence, the only question at present is of time; whether one after another they are created immediately; or whether they were all foreseen and provided at once? The latter predication involves the infinite; the former, the finite. Choose then whichever of these opinions seems most consistent with the Divine Essence. We leave the matter entirely to the decision of the reader.

§ VIII.

The reasonings of some philosophers concerning God.

We are now in a condition for understanding how it is that the philosophers, ever since the time of Aristotle, have racked their ingenuity in the attempt to express and represent to themselves and the philosophical world the nature and qualities of God. They all, as we said before, have begun by investigating these. In truth, mankind is always desirous to imagine the qualities of God; to bring him within the bounds of reason and rational ideas; and to finite and fix him in something, by something, or to something. For this reason the above investigation has all along been the issue and offspring of reason and philosophy. And though the philosophers have heard that he is infinite, yet on behalf of poor reason, which is always bounded by finite limits, they imagine the infinite as finite; being unable to perceive at all apart from the finite. We now therefore see why reason has failed, and that the cause is the same in the vulgar as in the learned. For the greatest master of learning can no better imagine what the infinite is, than the merest vulgar or the least informed of the community. Thus if we say that God is like an idol, or a man; or if we say that he is like the least or the greatest finite, it all amounts to the same thing; since there is no proportion between the infinite and the finite: wherefore it is as gross to say, that God is like the least or greatest finite, or that the least or greatest finite is God, as to say that the idol or image is like God, or that God dwells in the idol: or with the ancients, that this or that man is, or will be, a God. Finitely speaking the one simile is grosser than the other; but before God, as being infinite, both are equally gross. No finite difference makes any difference at all in the infinite, in proportion to which all finite differences are permanently the same; because there is no ratio, either of likeness, or unlikeness, between infinite and finite. The root and cause of all such perceptions as the above, is one and the same; viz., the very inquiry into the quality of the infinite, and the fact that when the mind could advance no further, it admired its last result, and accordingly took it for God; seeking its God from the ground of mere admiration, at the point where reason ceases, and thought itself is forced to stop. And hence it was that in former ages, when the simple-minded multitude greatly honored a leader, they at once deified him, and erected altars at which they paid him divine worship as their tutelar god. And when they saw any idol, to which they thought they could ascribe events that excited their wonder; particularly if miracles were alleged, and the admiration of the miracle prevented the perception of the cause; in this case they were lost in amazement; and consequently the idol or image became their god. Some have fancied the universe to be God, from seeing and conceiving in it such great and vast resources, which seem to transcend both sense and perception; or else from the circumstance, that the more they thought, the less did it seem possible to assign any limits in this sphere. On these grounds they deified the universe in its largest sense; and the more readily as their admiration for the whole was filled and illustrated by their knowledge of the astounding marvels and harmonies, of situation, figure and motion, which are extant in our own particular world. Others again deified the minimal or atomic world; from the same cause as before; viz., from admiration or ignorance of its properties; especially as under the operation of reason the minimum seems more and more to approach the indefinite, or to exceed the limits of conception. Others indeed believed in the infinity of God, and yet for the sake of representing his qualities to their own imaginations, they at the same time thought that he had finited himself, or had made himself finite, and so had created the world. And if these had held that all which there is in the natural sphere proceeds from an infinite cause, or from the infinite, and consequently in this respect is a divine work, they would not have been far from the truth: but the reverse if they concluded that the finite or nature is God, and that all things stand in nature's disposal; which becomes identical with the worship of nature. Others again thought that God is in such sense all in all, that the actual all of the finite universe is God; that we men likewise, as parts of the universe, are parts of God; according to which, whatever there is in the world is God: which amounts precisely to the same as the belief that universal nature is God; for it is like the former opinion, and springs from a similar ground. Others, to avoid all dissension, say that God is a spirit, but an infinite one, and that angels and human souls are spirits, but finite. Yet it must be confessed that even this is an incompetent statement. For probably when they talk of an infinite spirit, and a finite spirit, some likeness is implied between these spirits, or between the finite and the infinite, although the latter in itself admits of no such likeness. Or perhaps, as we do not know what finite spirits are, and as we do not know what the infinite is, it is from ignorance of both, and from admiration, the offspring of ignorance, that they wish to institute a parallel, and to call one the infinite spirit, the other the finite. Yet on account of the epithet infinite, it is all the same whether they choose to call it a spirit, or an angel, or this, or that, so long as it is not repugnant to the predication of infinity; for the conjunction of the infinite with any of these substantives absorbs whatever is finite, in short the whole of the other term. It is therefore all the same whether we say infinite spirit, or simply infinite. For if aught of finite is involved in the conception of spirit, it becomes intrinsically nothing in respect to its adjective, the infinite. Thus if you would illustrate the qualities of the infinite by likening them to those of finite spirits, and on this ground would speak of the infinite spirit, you would fall into the same error with the rest. For you admit that there is nothing infinite in angels, who are created beings. Therefore the illustration is not available in this sense, although it is not without meaning in a different sense, of which we shall speak presently. And from this ground it is that some have tried, in their way, to reduce the infinite to particular shapes or forms, likening it to a circle, to a triangle, or to this or the other geometrical figure; all which springs from the root we have already indicated; to wit, that men have chosen to reason of the quality of the infinite from the analogies of the finite sphere. They liken the infinite to a circle, because a circle has no end; or to a triangle enclosed in a circle, because it has a trinity of angles. In a word, they have attempted to perceive the *quale* or properties of the infinite by ideas framed upon a geometrical model; not seeing that quality is supposed in all geometrical entities, and that form cannot exist without extension. If we take the circle, this has necessarily a centre, and an area; which again imply angles, parts, and succession from point to point, constituting a line; or to say the least we have a conception of all these attributes in the circle; and in consequence we regard it as a natural entity, because it is analogous to a geometrical one: and the same remarks apply to the triangle. All enquirers then of all descriptions who have suffered their reason to seduce them, have tried to search out God by comparisons derived from the finite sphere, and so have fallen into error, and formed one idol or another to represent their Deity; and have all in this way become idolaters.

But as some have seen by the light of reason that God is not finite: that neither the universe, nor the maximum or minimum thereof is God, inasmuch as it is natural and finite, so they carried reason to a new height, and attempted to make out that the natural universe is not finite but infinite; that the heavens are illimitable and unending; that the world is eternal and everlasting; which was the belief of Aristotle and certain of his followers, who fancied that in this way they had found a God who was both infinite and finite. For example, they saw that the universe was natural, and to human senses, finite; but they thought that if they took away from it all its limits and boundaries, or supposed it to be circular, or could in any way ideally imagine it to be without end, they would thereby attain a knowledge of the infinite; which, in short, they regarded as nature without end, and as time without beginning. When they perceived that time involves succession, and is finited or distinguished by moments, to reduce it to the conception of the infinite, they declared the world to be eternal, time to be eternal. But had they chosen to reason deeper, they would have perceived that the one of these terms is contradictory to the other. If they recognize parts in the universe, they thereby recognize mere finites as composing it. If they recognize moments in time, they thereby recognize mere finites. How can this finite thing be infinite? How can it be without end? without beginning? How in any way can it have been produced without a cause? How without a beginning? How can so vast a universe be without boundaries? Each part has limits; why not the whole? However desirous you may be to conceive the finite without boundaries, you must answer these questions, after whatever anxious thought you will, by admitting that the universe cannot but have boundaries. Yea we add, that though you proceed on and on, through myriads of myriads of worlds, you still must come to an end: and as the world is finite in its parts, we may conclude that it is also finite in the whole: wherefore it cannot be infinite, or without end. Therefore these philosophers also are deceived, though not so grossly as the others; for notwithstanding their hallucination, they continue to affirm the intrinsic infinity of God; which they attempt to explain by finite things, making time eternal, the universe without end, and the finite infinite; not aware that the conjunction of the finite with the infinite causes the finite term utterly to disappear, and be reduced to nothing; the infinite alone remaining, and becoming all. And however they choose to add or multiply, subtract or divide; *i.e.* to perform analogical operations between the infinite and the finite, still the finite becomes a nonentity, and the infinite alone is left: so that it is all the same whether they make use of the finite in their calculus, or not; for here the finite has no value, no significance, may be either present or absent indifferently: and thus the infinite is infinite, and God is infinite: we cannot express him otherwise.

The infinite is not to be reckoned as nothing, although compared with finites it is quasi *nothing.*

But as we have spoken of the infinite and its qualities as if almost nothing could be predicated or conceived of it in a finite sense; as we have shewn that the reader is entitled to say that God is infinite in the least sphere, and infinite in the greatest, and that the finite is relatively nothing; or on the other hand, that the infinite, to our conceptions, is as nothing to the least of natural entities, or the natural minimum: so perhaps he may now be inclined to argue from this, that it is indeed necessary to assume the infinite, but nevertheless that it is equal to nothing. For when we multiply, or divide, a finite number by (0), the former becomes nothing. If we add or subtract (0), the finite number remains, and (0) can be wanting. Shewing that according to the previous conception, the infinite is nothing, because it is in a manner nothing relatively to finite numbers; and all the more as there is no likeness between the two. A number indeed may be so small, so indefinitely little, as in some sense to equal nothing, and although not really equivalent to this, yet it has a likeness thereto, and consequently it is not infinite. We see this in the calculation of indefinites, where the differences are so small, that they cannot be multiplied by constant finites without being annihilated; and their differences, and differences of differences, cannot even be conceived. Yet even these are by no means infinite, inasmuch as they involve a likeness or analogy to finites; by which as a proportional we may come to the investigation of quality in figures and spaces: while on the contrary no such analogy is supposed in the infinite. The mind, therefore, cannot help concluding by this process that the infinite and nothing are one and the same. But, friend, here too you are thinking after a finite manner. What do you say to the maximum Infinite? If you choose to state that God is infinite in the greatest sphere, is not all proportion with the finite lost thereby? The whole universe, with all its possible qualities, is yet not a point to the infinitely great. But can you then conclude that your finite is nothing, when your very senses and reason dictate that it is something; and relatively to those senses, vast enough to be indefinite, especially in the case of the finite universe? We may therefore logically argue, that the finite is not nothing, although it be nothing in relation to the infinitely great. Take the finite universe, and let thought go forth and expatiate over it, far and wide to the verge of possibility; then let thought extend beyond it, and conceive to yourself not only this universe, vast as imagination can compass, but an indefinite amount of similar universes: surely you cannot conclude, simply because you can conceive a repetition of universes *ad infinitum*, that therefore the universe, or any part of it, is nothing, although it is nothing relatively to the infinitely great. In the same way I would have you not confuse yourself, or conceive the infinite as nothing, merely because when it is represented to you in the minimal sphere, with relation to the finite, and the analogues of the finite, it is *quasi* nothing: for you may say the same of your finite relatively to the infinite represented in the maximum sphere. Whence you may conclude, but by no means finitely, that there does exist an infinite. Moreover the infinite is the cause of the finite, which it could not be if it did not exist. No cause can produce an effect, unless the power to produce lie in it: but that the infinite produced the primordial seeds of nature, and consequently the world, has been already stated. Actual NOTHING can furnish us with no cause: nothing comes of nothing. It follows that the infinite was the cause, and that whatever is in the cause is infinite. The circumstance of all contingencies in the finite sphere conspiring so marvellously to a single end, can proceed from no other ground than a cause involving an infinitely intelligent being; whence it follows that there is a preëminent being in the cause, and an infinite intelligence in the being. It is clear also that there is a link or nexus between the primitive and the cause, because whatever is most perfect in the primitive, is infinite in the cause; the nexus or link, however, is infinite, as we shall explain presently. Hence we may conclude demonstratively, that such nexus is possible, but as to its nature or quality, this can never be discerned by analogy in ever so remote a degree. Thus we may be certain that there are infinite things in the infinite, the nature and quality of which can never be conceived by the finite. The conclusion is, that beyond our finite sphere there are verily infinities, to the knowledge of which it is useless to aspire; and which in the infinite are infinitely many, and can be known to no one but the infinite. In order that these may in some measure be conceived by the soul introduced through faith into communion with the infinite, it has pleased God to discover by revelation much whereby the mind can finitely conceive and express him: not however that finite perceptions or expressions are similar or adequate to him, but only that those made use of are not repugnant.

§ IX.

The connexion between the infinite and the first finite.

Having now, by the formal resolution of the question of *cause*, or the *whence of things*, obtained this unknown *quale*, viz., the infinity of God, so that the human mind is plainly convinced of it; as also that God is in the infinite, or himself is infinite; we will in the next place follow the mind in the further enquiries which it makes as to the *how* and the *wherefore*. The infinity which the mind unhesitatingly ascribes to God, is now no longer assumed as unknown, but as known. By affirming it, the mind makes it positive, because it has no more to be sought, but is sought and found; though still indeed, however known and positively affirmed, the mind remains in the dark as to its *quale*. But enough, that this is no longer sought, and no longer dwelt upon. The mind being disembarrassed of this quest, it is not surprising that it now desires to go further, and to enquire into the *nexus* or connexion between the infinite and the finite, between the cause and the causate. In the course of reasoning, when the mind acquiesces in a point as no longer doubtful, it there leaves it, and ceases all attempt to descend into particulars where it knows that this is impossible. In the present case therefore it now comes closer and closer in thought to the first finite; but before taking hold of it, and determining to explore it, the mind proposes and ruminates certain middle questions, touching the actual existence of a nexus, and the possibility there is of discovering the nature and quality of the nexus which subsists between the cause and the causate, or between the infinite and the first finite. The philosopher hopes indeed to detect quality in the first finite, however he despairs of it in the infinite. Still, as we before observed, he assumes the infinite as known to the extent of affirmation.

When at length he fixes upon the nexus as an object of mental investigation, he directs his attention at one time to the infinite, at another to the first finite, hoping to discover the nexus from the latter, though not from the former; and stands hardly knowing which road to take, between some light and more darkness. And so he hesitates in his course, and asks whether a certain amount of illustration may not haply be borrowed from the finite side. In this way he elicits for his own mind the various states of the question, rejecting some and accepting others, until at last he sees one aspect on which he can dwell and reason.

Perhaps the reader may think that the present point is one which ought not to be enquired into, but that we ought to rest satisfied with what we know already. But what if reason does not rest, and cannot unhesitatingly believe many of the consequences which flow from our positions, until this doubt also is resolved? What then is to be done? Must we not enter, with the philosopher, into the field of ratiocination? Shall we not attempt to clear up the doubt and untie the knot by the aid of reason? Shall we not strive with all our might to make the nexus positive as we have already made the infinite positive? We have no right to despair of succeeding in this also, after solving, as we have done, that primary doubt which attached to the infinite.

In attempting to simplify and unravel the difficulty, it first occurs to us to enquire, if reason be competent to decide whether the infinite is the immediate, or whether it is the mediate, cause of the finite? On pondering this question, and carefully considering its philosophical relations, it is evident at once by all the laws of reason that there can be no mean between the infinite and the primitive. Were there a mean, or a middle cause, either this cause would be infinite, and therefore distinct from the first infinite; which would be contradictory of the infinite; (for how could there be two infinites, one the cause of the other, unless in point of infinity they were one and the same): or else it would be finite, and therefore distinct from our finite, and consequently a finite like the first; which would be to multiply entities unnecessarily; for the question is at present, Is there a cause intermediate between the infinite and the primitive? The suggestion then occurs, whether a middle cause be possible, partaking at once of the infinite and the finite. But this is soon rejected when we remember, that any finite whatever, the least or the greatest, attached to the infinite, would be equivalent to nothing; which proves that the two must be distinct. As it is evident therefore that no intermediate or proximate cause of this double nature is possible, the conclusion follows, that the infinite is the immediate cause of the finite or first simple. And this is the answer to the first question; so that it is no longer doubtful that the infinite is the immediate cause of the primitive or pure simple.

The primary end is for the infinite.

Next the mind goes deeper, and enquires into the nature and quality of the nexus between the finite and the infinite. It is evident enough that in point of essence the finite cannot partake of the infinite, because there is no ratio or relation between the two. Nevertheless the mind desiderates some nexus between the infinite and the finite, because the one is the cause, the other, the causate; and if the one depends on the other in the way of causate and cause, there must be a nexus between them, or a principle derived from the cause in the causate,—a principle to which the causate owes everthing. Therefore the mind assumes that there is a nexus; and this, not merely as regards existence, but also as regards essence. For unless the essence and its actuality were presently and continually dependent upon the cause, there could be no essence or actuality in the first finite; but as it is evident that there are both, so the mind will search for the nexus by way of analogy. Without a nexus the finite could neither exist nor subsist. Unless the principles in the first simple were related to the infinite by a nexus of some kind, they would evidently be annihilated at once, and dissipated outright; and the whole universe would perish with them. On these grounds the mind perceives that a nexus must exist; not indeed a perceptible, proportional, or natural nexus, or one which partakes of the finite: but still plainly a nexus; and it is equally evident, as it was before when we were speaking of the infinite, that it is impossible to know the nature of the nexus, because it must be absolutely infinite: although notwithstanding its existence is not the less clear. By consequence the mind acknowledges a something which it understands no better than it understands the infinite. We cannot in fact deny the nexus without at once destroying the finite, which derives from the nexus its very existence and subsistence, because its cause. Nor yet can we affirm that the nexus is perceptible, for it certainly is not perceptible in any natural or rational way. The conclusion then is, that there is undoubtedly a nexus, but that this nexus is infinite. The nexus is affirmed, but it is not known. We declare its positive existence, but pretend to no knowledge of its qualities. Here, and thus, the mind confesses its original ignorance, in that it can never discover the nature of the infinite by reason, however much it may choose to exercise that faculty upon the subject, for the utmost extent to which induction can attain is a bare admission of its existence.

Since we now affirm as a positive truth that there is a nexus, (but a nexus equally unknown with the infinite itself,) we may be more and more confirmed in our opinion by the answers to various questions concerning the creation of the world; as the end of that creation; the why and wherefore; the immediate purpose; the impelling cause. If there were really no nexus, there would be no *wherefore*, or end, in the case. The end stands related to the beginning; and the last cause to the first; but such relationship would be impossible if there were no nexus: the mutual relation of ends consists wholly in the nexus, whatever that may be. The final cause cannot be primarily for the finite. Were it so, then all effects would be simply for the same, and the efficient cause would have no end to exist for. This would be at variance with its infinity; for if there be a nexus, and the infinite be the first cause of all, it is impossible but that all its successive derivations must be related through the nexus to the first cause. The whole sphere of the finite, or the universal world, must of course be referable to its own prime, beginning therein, and terminating therein. Therefore the final or impelling cause cannot be in the means, but only in the end itself; nor can it terminate in the finite sphere, but only in the infinite. And thus all the multiplicity of causes that concurred to the existence and creation of the world, can neither end nor begin anywhere but in the infinite; whatever proceeds therefrom consists merely of causates. Nor can it be said that any cause concurring to creation exists elsewhere than in the essential cause itself, *i.e.* in the infinite. Were we to declare that the infinite created for no cause of its own, but purely for the sake of finite beings, in this case a particular act of will would be conceived apart from the nexus of causes; an intelligence would be conceived in the will without a cause; an efficiency proceeding from the will without either a cause or an end; all which would involve contradiction or negation in the infinite. If then all that there is in God be infinite, there must also be an infinite exertion of will for a cause, as well as an infinite intelligence in the will, and an infinite efficiency from the will: in short without a cause, no principle whatever is conceivable in the infinite. As then the infinite is in this will, and cannot be otherwise, so it must also be in the cause for which as an end [the creation was effected] : which cause consequently cannot be other than infinite, or other than primarily for the sake of the infinite; or what amounts to the same thing, for the sake of itself. In this way then the whole universe, and the whole sphere of the finite, was not created primarily for the finite, or for men and souls, but for itself; otherwise there would have been no infinite in the act of will which produced it; in which however the finite could not have been, and the infinite must. The final cause, therefore, or the end; all the effects which are ends; all the means which in themselves are ends, although in relation to subsequent issues they are causes, and in relation to the two extremes they are means,—all, we say, are for no other final cause but God alone.

Seeing then that all things are created for the infinite, and that the final cause is infinite, as the beginning or first cause is *the* infinite; both causes being therefore identical, *i.e.* infinite; we may now perceive that there must of necessity be a nexus between the infinite and the finite. Causes and ends cannot be connected without means; cannot be related to each other without a nexus. Hereby the affirmation is strengthened of the existence of a nexus between the infinite and the finite; though its nature reason can never know, because the nexus too is infinite. Hence the position of existence is affirmed, at the same time that that of quality is ignored.

But possibly some of our readers may think they have reason to object, that according to this, the ultimate end of substances, or ultimate natural effects, would seem to be infinite; although they are as far from being so as the infinite is far from the finite, *or in common* parlance, as heaven from earth. For they urge that the first natural entity is that least or minimum of which we had made such frequent mention; and this first natural entity is not infinite, but the infinite is simply its cause. And as the first natural entity is the cause of the whole series, so the last must be like the first, that is to say, finite and natural, and by no means infinite. Again as there can be nothing infinite in the first natural entity, because the finite and the infinite cannot coexist as proportional constituents of one and the same thing, so there can be nothing infinite in the last. Or to speak more clearly, such coexistence cannot be conceived, although if stated there might be no contradiction in the words. Consequently all the ends of nature, all the boundaries of natural things, begin and end in the finite sphere. To all this we beg to observe, that we are speaking at present of the first and last final cause; and seeking the end for which these natural boundaries were created. The first cause cannot be anywhere but in the infinite, for it has nothing natural in it, but the natural begins in the first entity produced by the cause; by which natural things become means to this infinite end. Therefore the ultimate end of such cause cannot consist in any simply natural realization, but only in a connexion with the same cause by natural means; and so the first and last ends are connected together, and consequently are infinite, or for the infinite. Hence all things tend to enable natural means to conspire to that end, and as man is a mean to it, so he too enters into communion with the same end, not however as being himself an end, unless in a secondary sense, but only a means. But of these subjects we shall treat more at large in the sequel.

§ X.

There is a nexus, and the infinite is the final cause of creation.

We thus arrive at the second of our unknown quantities, and this likewise by reasoning; and we have, therefore, now no right to despair of arriving by reason at anything, be it even so profoundly unknown; howbeit it is not equally permitted us to attain a knowledge of quality as of mere existence. Still we have got so far as to believe in a nexus between the infinite and the finite, but not a natural, neither a mechanical, geometrical, or physical nexus, nor one of any kind that has any analogy with the qualities of the finite. In a word we know that there is a nexus, but what it is we know nothing whatever. This too may therefore be reckoned among affirmative and positive verities. And likewise this, that as there is a nexus, all things stand related to the first cause through the nexus; and that the primary final cause exists entirely for the first cause; wherefore both ends agree in this, that all things are made and created for the infinite. Let us now go further, and see whether anything more be discoverable by the reasoning process.

First, however, let us see, whether there be any source besides mere reasoning, from which we can know the existence of the nexus. To illustrate what we mean, let us suppose that some other person now tells us the same thing that we ourselves had discovered by reason; in this case we shall be bound to think that he too has discovered it by the same process. And if any one told me the same, but gave additional particulars coinciding with it, which went still more to confirm it, then it would be fair to believe, that he had reasoned more deeply, distinctly and acutely than myself; since he not only sees all that I do, and draws my conclusion, but superadds new results, of which I knew nothing, yet which are nowise at variance with mine, and therefore I have every reason to believe them. And hence the mind that would not be deceived, lays hold both of that which is concurrent with its own reasoning, and of that which other minds superadd, and which appears to be not at variance with the former.

But perhaps the reader may be curious to know my drift in these remarks, and he may ask what greater degree of affirmation I want on the subject. I wish then only to draw this conclusion, that if any one tells me the same thing that I myself have arrived at, I am bound to believe him on the simple ground that I believe myself. Let us now see whether God himself, or the infinite, has not been pleased to reveal to us this very thing; for he tells us that he had from eternity an only-begotten son, and that this only-begotten son is the infinite, and is God, and that the connexion between the finite and the infinite is effected by the only-begotten infinite and God; and that the father and *the son are one* God; both infinite; both the creator of the finite universe; that both concurred in the work of creation, yet that the two are so distinct, that the one is the Father, the other, the Son; the one the first person, the other the second; wherefore in respect to the names of Father and Son, and in respect to the word Person, they are indeed two, but in infinity and divinity they are one and the same. In this way we have here something like what reason had dictated, to wit, the existence of a nexus between the finite and the infinite; also the declaration that the final cause belongs to the infinite, but through the above nexus; and that the connexion between the infinite and the finite is through the Son, and through nothing else. Thus then we have an agreement of revelation with reasoning.

But here again some may choose to infer as a philosophical conclusion from our premises, that in this case God created the finite universe mediately and not immediately; for if the nexus between the finite and the infinite lies in the only-begotten Son, the latter is then the real medium through which the universe was created. But why, I ask, should we reason so naturally? why so finitely? We see already that there is a nexus; that the nexus is infinite; that the infinite does not admit of distinctions like the finite; so that it is impossible to say with any meaning that there are two infinites, or that the infinite is divided, or that one infinite has done anything through the other; for herein we should be again desiderating a *quale* in the infinite, in which no *quale* can be found as in finites; wherefore neither finite terms, nor finite reasons and perceptions, can have place here. If you say that there is a connexion between the infinite and the finite through the Son, and add that the Son or nexus is infinite, this amounts to the same as saying at once, that the infinite is the immediate or proximate cause of the creation of the finite; for you cannot make one infinite prior to the other in time, or nearer than the other in place, or imagine any medium of a finite kind, since the infinite can be no other than one. Therefore, the Son being infinite, the infinite is the proximate and immediate cause of the finite. Thus it is the same whether we say that the Father is the immediate cause of creation, or the Son; for as we have often observed before, the infinite admits of no finite or natural distinctions. To say then that the finite came forth mediately through the Son, is exactly tantamount to saying that it came forth immediately through the Father, or immediately through the Son; since the Father and the Son are alike the infinite, and the infinite is the immediate cause of the finite. In short we may in a thousand ways play with words expressing the finite, and with reason also; for all our speech and reasoning is necessarily finite. However, if you choose to state that there is a connexion between the infinite and the finite through the infinite, and consequently through the Son, as infinite, I hardly think you can be far wrong. At any rate to whatever quarter you turn, or however forcibly you entreat your reason, you will never elicit anything more, than that the nexus is infinite, and that revelation therefore coincides in declaring, that the world came forth immediately through both the Father and the Son.

§ XI.

But as we have now committed reason to the subject of the nexus, and it is desirable not to leave it there, plunged in sheer stupefaction and amazement at the innumerable things that it sees, of which it is to remain for ever in ignorance; as this is the case, we will proffer our hand to reason for another stage of the journey, and to the best of our ability direct her on the way, pointing out how far it appears possible to venture, in these mysteries, and where we must necessarily stop. We said above that reason would avail us to the point of knowing that there is a God, and that he is infinite; but that it would not avail to that other point, of shewing his nature, or the nature of the infinite. We said also, that reason may see as a last result of induction, that there is a nexus, and that the nexus is infinite; but that it cannot know what the nexus is, simply because it is infinite. It remains now to be seen whether there are not a vast number of other particulars touching these subjects, which we may fairly arrive at by reason, and come to know the existence of, although not the nature. When the mind is satisfied on the question of *existence*, the next thing is, to enquire how the question of *nature* or *quale* may best receive that illustration

Man is the ultimate effect in the world through which the divine end can be obtained.

of which it is capable. But we have not yet arrived at this part of the subject. The questions concerning existence will in the meantime afford us many affirmative and positive data, from some of which the question of quality may to a certain extent be elucidated.

We said above that the primary final cause belongs to the infinite, or exists for the infinite, and is obtained by finite means. For if there is a final cause at all, one for which all things exist, (which presupposes an impelling cause,) there must then be ends, *i.e.* a first end and a last. Such an end as the first and the last, can only exist by means of a subject which has a first, a middle, and a last term. And as the final cause cannot be obtained but by ends, it follows that it cannot be obtained but by a peculiar subject which has ends; that is to say, by the finite, or by the world considered as finite. If it can be obtained only by ends and boundaries, then there must be two finite ends, a first and a last; to say nothing of middle terms, of which we shall speak at length in another place. With respect to the first natural end, we have said that it is the first created minimum, the smallest natural seed, or the simple principle of the world. We shall now leave the middle terms, and pass at once to the last natural end, through which the divine end must be obtained; which, as respects its first cause, is the infinite; wherefore the final cause is infinite, and therefore the same in the first end as in the last; and so the first and last cause are at one in this, that they both exist for the infinite.

Now then the question is, where or what is the last effect in the natural or finite sphere by which this final cause can ultimately be obtained? We reply that for this planet the last effect is man. We will not now expend our attention on other worlds, or enquire whether there are any such, or how many, or whether they too contain planets, or whether in them also there are ultimate effects by which this final cause is obtainable. Denial or affirmation on these points is irrelative to our argument; for we are not now canvassing them, nor are they in question at all. But we are here speaking of our own planet, and we aver that man is the last effect thereon by which the end contemplated by the infinite may be realized. We will now enquire whether men are these last effects we are in search of, or angels, if the reader believes in angels, or whether anything else is to be so considered. It is no longer denied that the natural minimum, the seed or primordial germ of nature, is the first effect. This admission gained, let us proceed in our investigation. Intermediates are necessary to the obtaining of the ultimate effect. It would be contrary to all reason for the ultimate to be in the intermediates, or the end in the middle. Therefore the elements cannot be the ultimate effects, for they are the intermediates which provide for the existence of the ultimate effect, and give it being. Ether, air, fire, water, cannot be what we are seeking; for they are only means, and besides are inanimate; and so far present us with nothing of a living and intelligent character into whose composition they enter; therefore they cannot be ultimate effects. The earth with the various growths that adorn it, cannot be the ultimate effect; for in the latter all the means must concur. What is the use of the means but to constitute the ultimate effect, by which alone the end can be obtained? It is indeed obtained by means, yet only by the means leading to the ultimate: whence there is nothing in the world but conspires to the same end or *finale,* to obtain which all things must conspire to the ultimate effect, in which, in this manner, the end will exist. We see then that in the subjects we have mentioned, something is still wanting, that is to say, some ultimate effect. Now therefore let us come to man, and let us see whether all things conspire to make him the ultimate effect, through which the said divine end can be realized. In him all other things concur as means: all the elements concur to his life, to his senses, to his reasoning power, &c. Whatever be the nature of the elements, or our opinions about them, they must exist in a series, the subtle first and the gross afterwards; otherwise the body would be without breath or life, and its finer parts would be destitute of motion, nay, destitute of the very springs of motion. At least the subtler elements concur to produce or to move the grosser, for no motion can be induced upon bodies without a cause, or without principles of motion derived from other substances. And if motion contributes to the life of man, the subtler elements are still the means, and in this way conduce and tend to realize the *ultimate* effect. To whatever class of philosophers the reader may belong, he must admit, if the subtler elements concur to the existence or subsistence of the last, and this last concurs to realize a particular effect, that then, in all reason, all the elements necessarily concur to realize the same. We know, however, by the senses, that nearly all things do concur in man. We see that water, fire, and earth contribute to form and sustain him. For he is nourished by them; he is made up of them; his blood and humors are rendered liquid by their instrumentality; he also obtains heat from the same source; out of the air he takes hearing; out of the ether sight; and if we chose to proceed, we might shew that the subtler elements likewise, both severally and in combination, concur to endow him. Neither the elements then, nor the elemental world; neither the matters of the earth, nor the planet itself; no, nor the vegetable kingdom, can be regarded as ends, inasmuch as they all concur to make up and support another finite being as their last result. If it be objected that numberless other occult finites, as souls, angels, &c., possibly exist in nature, which perhaps do not concur, I still answer, that nothing can by any chance exist in nature, be its sphere as subtle as it may, no not even angels, but with a view to concur in man; not indeed to concur to his formation, yet to the obtaining of the divine end in man as the ultimate effect of the world.

But it may be thought that, at this rate, we only prove that man is the ultimate effect of nature in point of existence, *i.e.* the last in time; and if this were all it might then be argued, that other animals too are ultimate effects, as their composition, senses and mechanical organs appear to be similar to our own, and all the before-mentioned series concur to produce them, just as they concur to the corresponding parts and endowments in man. How then can it be said that man is the ultimate effect through which alone the end is realized, when by the shewing of our very senses, the same ultimate effect is evidently presented in other living creatures also? But let us proceed a step further. The ultimate effect we are seeking must have more in it than a mere machine: by a mere machine the divine end could never be realized. If it could, the whole universe might justly be regarded as the ultimate effect. A mere machine, however, can only serve as a means to the ultimate effect. In the ultimate machine something more is requisite; something not merely passive; something active in addition to the passive; in short, something that tends and contributes to the end of creation. This end does not come of itself, or result from a mere machine, unless the latter has in it something by whose instrumentality it is enabled to concur to produce the end. Much as in an ordinary machine, the force and power lie not in the matter but in the mechanism. And so in the ultimate mechanical or material effect of the world, there must be a power and a principle which if not active and causative, is at least admissive or receptive, and by which the machine is enabled to acknowledge and to contemplate God. There must therefore be something that can comprehend the end, that can acknowledge the end, and acknowledge also, in the fulness of faith, that the end is infinite. Without such a power and endowment, an ultimate effect embodying the divine intention is inconceivable. But animals have not this power, nor can they have any comprehension of its object. There must then be a mean whereby an endowment so necessary in the ultimate effect shall be present there. There must be not only a body, but a soul; and not only a soul, but a conjunction between the soul and the body, and consequently a rational man. Hence rationality is given to man through the soul and body at once, that the divine end may be realized. We see therefore that man is the ultimate effect on our planet; the effect through which this grand result may be obtained.

§ XII.

It is evident from the foregoing considerations, that man is the ultimate effect of nature, intended to realize the divine end for which the world was created; and that unless the first and last final causes, or the impulsive and the final cause, could combine in this ultimate effect; so as to be one and the same in either end; or so as to present a connexion between the infinite and the last end, as there is between the infinite and the first; there could be no final cause, still less one that respected the infinite. Therefore in this ultimate effect, namely man, dwells the veriest final cause of creation. But for this last cause in the finite to respect the first cause, there must be something in the same finite, that can, and does, partake of the divine and the infinite: were there nothing divine or infinite in the ultimate finite effect, the infinite could have no final cause respecting it in the finite. But this perhaps startles the reader, and prompts him to enquire what new distinction I am drawing, and why I speak in such manifest opposition to principles and reason; for how can the finite possess aught of the infinite, when there is no ratio between the two. Good reader! have a little patience. I say that as the end of creation is purely divine and infinite, and as it is realized nowhere but in the ultimate effect, which is man, so it follows in all reason, that there must be something divine, or receptive of the divinity, in man; otherwise the end is not obtained. But hear now in what this divine or infinite predication may consist. Not certainly in the fact that man is an animal, and has senses provided him to enjoy the delights of the world; nor in the fact that he has a soul, for his soul is finite, and can contain nothing of the infinite. Neither in reason, which is the effect of the coöperation between the soul and the body; which as they are both finite, so the effect of both is also finite: therefore it does not lie in reason. So far we find nothing divine in man. Where is that then which appears to be nowhere, and yet is necessary to realize the divine end? It ought to be present in the subject to be fairly predicated of it. We answer that in spite of any difficulties in the case, we may nevertheless learn through reason what this divine principle consists in; in short that it lies in the circumstance, that man can acknowledge, and does acknowledge, God; that he can believe, and does believe, that God is infinite; that though he is ignorant of the nature of the Deity, yet he can acknowledge, and does acknowledge, his existence; and this, without the shadow of doubt: and especially does it consist in this further privilege, that by that undoubting faith, he is sensible in love, or delight resulting from love, of a peculiar connexion with the infinite. But where he doubts, he does not acknowledge, and the divine is not in him. All divine worship proceeds from this fountain of faith and love. Of worship, however, we must treat in another place, the subject being one of immense extent and difficulty: enough for the present to know that it is given in revelation. Thus the true divinity in man, who is the ultimate effect in which the divine end dwells, is none other than an acknowledgment of the existence and infinity of God, and a sense of delight in the love of God. Here then is the solution of the problem. Yet this divine principle could never be realized in man, unless his body had a soul given to it out of the purer and more perfect world, and unless reason were accorded as the fruit of the intercourse between the two, with a power of concluding by self-contemplation, by the view of effects, and by everything in the world, that there is a God, and that He is infinite; although human reason cannot do this of itself, inasmuch as man, with all his parts and his very soul, is finite; notwithstanding which, he may be a fit recipient, and as he is in the finite sphere, he may concur to dispose himself for reception. Thus we see that the end is obtainable through man alone, and through no other creature, although other creatures may be regarded as means to the existence of the ultimate effect, and therein of the divine end. Therefore the acknowledgment of God, with faith for its ground, is the foundation of all divine worship.

§ XIII.

Objection: That the divine end is not obtained in the ultimate effect.

But while the mind is thinking on this subject, many perplexing considerations cannot fail to arise, and first it may be argued, that if the above were the impelling cause of creation, or what is the same thing, were the final cause in the infinite; and if man be the ultimate effect designed to realize the divine end; then it is evident that although there is the final cause in God, yet the infinite has not obtained his end. From which it is inferred, that failure in this respect argues a certain imperfection and finiteness, destructive of the divine infinity in the cause. For if the end does not answer to the cause, what becomes of the infinite in the cause? Besides which, we do not see that there is any divine end in the ultimate effect *per se*; and how is this difficulty to be surmounted?

Before we can solve it we must recur to our principles, and institute an examination of our first finite, after which we shall be prepared for advancing. We have gained thus much, that the infinite is the cause of the finite, and that the first finite is most perfect or most perfectly finite; for nothing but what is thus perfect can proceed immediately from the infinite. God alone, as we said above, can be infinitely perfect. Were anything else so termed, the adjective perfect would be simply destroyed, leaving the infinite only, which is God. Yet although, save God, there cannot be anything infinitely perfect, there may nevertheless be that which is finitely most perfect, as coming proximately and immediately from the infinite; yet even this is but finitely perfect, and involves mere finiteness, and nothing whatever of infinity. Nothing but what is most perfect can proceed from the infinite, and as the primitive proceeded immediately therefrom, so nothing but what is most perfect can be predicated of it. If there be a nexus between the infinite and the primitive, then whatever is most perfect in the primitive, is infinite in the cause. Thus all that there is in the primitive, is superlatively perfect by its derivation from the infinite. The eminent perfection of the primitive may be divided into innumerable particulars as its grounds, all of which are infinite in the cause, and therefore do not forbid us to attribute them finitely to it, although there is no ratio or analogy between the primitive and the cause. Let us grant then that the primitive is most surpassingly perfect in the finite sense, and now let us see whether all its consequences or derivatives can by possibility be equally perfect in the same sense, or whether the primitive alone can be so. To aid our conceptions we will take but one illustration of perfection, as an example of the most perfect state, and confine ourselves to that, in order not to distract the mind. All the least and simple entities or first natures of the world—all which are produced by the infinite immediately—are finitely speaking most perfect; and therefore also most self-similar. Finite perfection of this order admits not of dissimilitude. Otherwise it would not be what it is, but the perfection would be at fault and never reach the summit. It must therefore be granted that the above primitives were most self-similar, because most perfect or most perfectly similar. Now let us come to the derivatives and consequences. Whenever a compound issues by derivation from perfectly self-similar primitives, many of which together are required for its production, it is evident that modes must at once be called into existence. No compound can be formed without them. We will suppose then that the first mode coming from the first most perfect entity, is as perfect as its source; for no most perfect and self-similar essence can produce any mode, or any second thing by a mode, without the mode immediately adhering to it being similar to its antecedent essence. On this ground we may grant that the first modes, like the first entities, are most perfectly self-similar. Furthermore, contingencies must concur before anything can be produced by modes. Let us see now whether, finitely and rationally speaking, anything that is most perfect can be derived from the first most perfect entity, by modes and contingencies. We say that as the first is finitely most perfect, this is impossible, and contrary to the very definition and conception of the finite; *i.e.* if the finite compound requires to be finited more and more by finites, and if this necessarily take place by modes and contingencies. Granting even that contingencies and modes existed in the superlatively perfect primitive, and in themselves were equally perfect, still it does not follow that other derived contingencies, modes and substances can be perfect in the same degree. Were all things, from first to last, equally perfect, were they all most perfect, the finite would not exist. If the world is to have being, more or less must be admitted in perfections, namely, of the scale or series; succession also and degrees: without degrees no finite properly so called is possible. Were the perfection equally consummate throughout in the derivatives of the series, the finite would not be true to itself in point of perfection—it would not be finite, because there would be no degrees,—no perfect, more perfect, and most perfect,—but all together in this respect, or abstractedly from substance, it would be infinitely perfect, in short, infinite. Therefore as it is finite, and the essence of the finite consists in its subjection to degrees, and to the laws of succession and derived substantiality, as well as to other predicaments which are inseparable from the finite proper; so of necessity in the derivatives, both through modes and contingencies, the likeness itself can never amount to identical similarity, but on the contrary must involve degrees, or degradation from more to less. Granting then the one proposition, that the primitive was finitely most perfect, we have also obtained the other, that there were finiteness and degrees in the perfection; so that by derivation the subject becomes successively less perfect, and images the perfection of the primitive less and less. For all that is finite must admit of a succession of different states: the infinite is the only being to which this necessity does not apply.

And from these considerations it follows, that all derivatives are perfect exactly in proportion as they are near to the primitive; for the greatest finite perfection becomes less and less in succession. To shew this we will again instance the perfect self-similarity of the primitive. Now this similarity cannot be equally perfect in the derivatives, because it is finite, and because the finiting process by which the compound is made, takes place with successive increments through modes and contingencies. Therefore the same self-similarity cannot exist in the ultimate derivatives; we mean the same absolute and most perfect similarity. Experience and nature both attest the truth of this; for in these derivatives there is no one thing that is absolutely or most perfectly like any other. This is a rule in derivatives, and applies to all natural compounds whatever. Thus the superlative degree of perfection cannot exist in derivatives, because they are finite, and the infinitely perfect cannot exist in finites. And by consequence, whatever of imperfection, or of lessened perfection, there is in nature, has its rise immediately from finites. From the infinite it can derive no conditions but those of superlative similarity, perfection, and purity.

Let us now proceed to man, who is the ultimate effect of nature, with a view of seeing, whether anything superlatively perfect in a finite sense can exist in him, or the contrary. We answer in the negative. We say that as he is the ultimate effect of nature; as he is made up of all the intermediate effects; as he is finite, and many times finite; and as his soul may obey his body, and thereby become like his body; so that which is superlatively perfect in a finite sense is impossible in him. This is a consequence of the antecedent proposition. And we know not if it may not even be taken as an axiom, that perfection indeed may exist in man, but naturally speaking by no means superlative perfection, which may be manifested in the primitive alone, and nowhere else.

§ XIV.

God has exercised his prevision and providence at once, to ensure obtaining the primary end.

We shall now be asked how the divine end can be obtained, unless the last effect of nature be similar to the first? For if the divine end is to be obtained through the finite, it cannot possibly be obtained, unless by the constant presence of a superlative perfection in the whole series, causing all things to conspire to this divine and infinite end. Not, however, to moot this question at present, though it must come before us shortly, we may observe that at any rate all the means cannot conspire to the above end, unless they too are similar in perfection to the first principle: and here suffice it to say that naturally speaking this is impossible.

The infinite could not but foreknow this, and as the end was divine and infinite, could not but at the same time provide to meet it. For as the end is infinite, and as God is infinite, so his foreknowledge—his PREVIDENCE—cannot be distinguished from his PROVIDENCE, but the two are one and the same to the mind: in fact, were they divided, we should at once come into the sphere of the finite. Therefore foreknowledge and providence were present together to obtain this end. Let us see then what was the nature of this combined or identified previdence and providence; which we may now do in a finite manner from the effect or *a posteriori*. For as the corporeal part of man could not possibly be the superlative perfection of finite existence, being so low in the series of derivations, and so distant from the perfection of the primitive; and as Deity foreknew this condition arising out of the finiteness of the subject—foreknew that the body or the last effect could not have the above perfection;—therefore he at once provided for the case by the creation of the soul, which he made rational, and consummately rational, and indeed most perfect, so that it might rule the body. A soul that should have dominion over all parts of the body at once. A soul without which the body could do nothing, but which should dispose the whole and the parts at its sovereign will. A soul without which nothing should be admitted into the human will. A soul without which neither a single condition of will nor of action should be manifested in the body, or by the body. Now in this we recognize a Providence; in the circumstance, we mean, that a consummately rational and perfect soul was given to man, with a power of so governing the body, as that the whole corporeal frame, with all its parts, should singly tend to the above end, namely, to the divine *finale*. With a view to which, and by means of the superlatively perfect connexion subsisting between it and the body, the instant obedience of the whole and the parts is surrendered to it. That thereby it, the soul, may make the body, intrinsically imperfect though it be, in its own likeness; or in the likeness, and with the superlative perfections, of its own natural minimum.

By giving a soul to the body.

And as the soul, though finite, is comparatively similar and near to that most perfect first principle; for all dissimilitude proceeds simply from remoteness, and from the law of series and derivation, according to which the perfect becomes less so by degrees;—as, we say, the soul is comparatively near to perfection, so, when left to its own disposal, it would seem that it could not fail to aspire to that end in a purer manner; and therefore,—I am now speaking of the soul of the first man,—to desire to constitute the body in its own likeness, and to govern it as such; for it had the power, inasmuch as nothing could be done without its knowledge and concurrence. But as the soul was not alone in the government of the will, but exercised its rule in conjunction with the body, so its efforts—its *nisus*—could not by possibility be exactly identical with, or perfectly similar to, the *nisus* of the body. For since the will depended upon the reason, and the reason on the soul and the body together, hence the one must have governed the other; which would not have been necessary had the will depended simply on the soul, without the body being involved in the compact. And here we might expatiate at great length on the free-will of man, and specifically on that which the first man enjoyed in worldly things; and on the intercourse between the soul and the body as concurring simultaneously to the faculty of will; but we must not now meddle with these subjects, lest they should disturb the course of our argument. Let us therefore continue the thread where we left it, and proceed with the conclusion, that the infinite Deity has exerted both prevision and providence, in making all things tend to the divine end; and this, through a soul destined to have dominion over the body, and with the body to govern the determinations of the will: through a soul which was endowed therefore in the first man with a superlatively perfect direction to that primary end.

But perhaps it may be urged, that the Supreme Being having foreseen and provided, that the soul he had given to man could not absolutely dispose all the parts of the body at its own pleasure to that primary end, but that it would succumb to the body, and the action of the body prevail in the will, and thereby the primary end would necessarily be lost; as the Omniscient and Omnipotent Being foresaw this; why did he give man a body of the kind? Why did he give him a soul which was unable to govern the body? Why did he make an ultimate effect which *could* fall? Would not this seem to argue, that the ultimate effect was not under the direction of the infinite, and did not exist for the ends of the infinite? The objection is specious enough. Yet as the infinite is not chargeable in the case; especially as the whole of primal nature was in a finite sense superlatively perfect; and finitely speaking, as all the means conspiring to that end, were given; so that the first man could, if he would, have been faithful to the end; and as we in no way detract from finite perfection, in declaring that all the parts in man might have conspired to that end in the most perfect manner, provided only the will could have been governed by the soul: and as the soul could not possibly be alone in the ultimate effect, or act by itself, without the fellowship of the body; as it could not singly have dominion in the will; so it was not of possible attainment, that the whole ultimate effect, in all its parts, should tend to the end, precisely in the same manner, or with the same consummate perfection; nor on the other hand that the effect should live intelligently without communication with the soul. In fact, without the combined agency of both the soul and body, the end could *never be* obtained, inasmuch as it was obtained in the ultimate effect. But these subjects will be better seen hereafter, when we have treated of the mechanism by which the soul and the body communicate with each other, of their respective governments, and also of the will; which matters we intend to discuss in the work to which the present treatise is preliminary.

But to continue the tissue of our discourse, which it would be unwise to interrupt, since we might thereby hinder the mind from seeing the tenor of the divine foreknowledge and providence: as God foresaw that without a rational soul the body could not be a mean to the primary end, so he provided that a consummately rational soul should be given to it, or that reason should be given at once to both body and soul, to enable man to acknowledge God, and become a mean to the end. And having given and connected these two, he also foresaw that the body would command the soul, and that the will common to both, could and would, obey the body in preference to the soul. In this case providence went hand in hand with previdence. In short, the Deity provided means by which the primary end should be realized notwithstanding. He provided that on the part of the body itself there should be a connexion of the finite with the infinite; that there should be a nexus in the last effect equally as in the first, (of which we have spoken already). He foresaw that no nexus was possible between the finite and the infinite, unless the nexus itself were infinite; as a necessary consequence of which, the connexion between the last effect, namely, man, and the infinite, must have place through the infinite; otherwise the divine end could never be obtained. Now by the fall, and the dominion of the body over the soul, the connexion was broken and the end would have been frustrated. But God provided against this by his infinite, only-begotten Son, who took on him the ultimate effect of the world, or a manhood and a human shape, and thereby was infinite in and with the finite, and consequently restored the nexus in his own person between the infinite and the finite, so that the primary end was realized. Thus we see that all things have conspired to it; that to further it man has a soul given him, whereby he becomes a rational being: that the soul and the body have a divided and at the same time a combined dominion in the human

By the only-begotten Son, who took upon Himself the ultimate effect.

will: that as the Deity foresaw that the issue of this dominion would be unhappy, he provided for the event by a connexion of man, or the last effect, with the infinite, Who thus himself became the last effect, at once God and man, the Mediator between the finite and the infinite. That so by him alone, and through our connexion with him alone, we ourselves are ultimate effects to the primary end. And that without him there would be no connexion between the last effect and the infinite; whereas through him somewhat of the divine may dwell in us, namely, in the faculty to know and believe that there is a God, and that He is infinite; and again through Him, by the use of the means, we are led to true religion, and become children of God, and not of the world. This, however, is not the place to enquire what the nature of the above connexion is. For the present let us be content with the certainty, that through the only-begotten Son of God, the first finites are connected with the last, and both with God; and that the nexus itself is infinite in the last and the first alike; as we stated before.

How the end may be obtained in the Gentiles.

But perhaps the reader still feels a difficulty, and thinks, even granting what we have stated, that the divine end is not obtained thereby. For have we not declared, that it cannot be obtained in the ultimate effect, unless by a connexion between the infinite and the finite in the only-begotten Son; and of consequence, by faith; true and steadfast faith being the only means to obtain it. And yet it is a well-known circumstance, that scarcely one-third or one-fourth part of our race is aware that the only-begotten Son of God assumed the human form; still less, that our sole connexion with God is through him; and that the foundations of faith are possible through him alone. And it is equally certain that before the coming of the Messiah nearly all mankind was in the dark; and even the Jews themselves were no better; for they believed for the most part that the Messiah was to come, not for the cure of souls, but for empire in the world; to give their nation universal sovereignty; an opinion which is still entertained by that people. On these grounds it might be thought, that no divine end could be obtained, save in those few who knew and believed, during their sojourn in the world, that the Messiah would come, and did come, for the salvation of our souls. But let us turn to those who had lived in ignorance for ages before the Messiah came, and to those now alive who were and continue ignorant that the Messiah assumed the human form, to connect us, as imperfect beings, through likeness with Himself, with the divine end; and consequently not only to capacitate us for the reception of faith, but also for actually living in the divine end. Now the question is, whether those who were and who are ignorant of the coming of the Messiah, could, or can, be in the divine end? I answer that they can. For whoso has faith in the Infinite, does not exclude from faith the only-begotten Son. It is true he does not distinguish between the two, because he cannot; nor can the persons in the Godhead be distinguished in faith in point of divinity and infinity. Hence those who can believe implicitly in God and the infinite, thereby implicitly include all that is infinite in God, yea, even those attributes of which they themselves are ignorant. And as there is a divine essence in faith, so therein the one infinite is inseparable from the other. And thus although the Gentiles be ignorant, yet even in this point there can be no negative principle, for if they believe in the infinite, they comprize all that there is in the infinite. Nevertheless they can neither become partakers in the divine end, nor believe, nor be saved, otherwise than through that infinite nexus, without whom there is no salvation. The only question remaining therefore is, whether we are made partakers of the divine end by the advent of the Messiah, by his assumption of the form of the ultimate effect, whereby he has connected it with the infinite; or whether, for this result, we also require to possess a knowledge of his advent? I reply that those who did not know, and do not know, that He has come, could, and can, become partakers, by the grace of God, through his coming; for otherwise we should suppose something in God that would seem at variance with his divine nature and end. But as for those who know the Messiah, or have the opportunity to know him, we say that they too are made partakers through his coming, but the knowledge also of his coming is necessary to them, in order to their faith; for the quality of faith is determined by knowledge, and its perception rendered distinct and full; and therefore where knowledge is given, it and faith are inseparable. But on this head we shall have more to say when, in pursuance of our present plan, we come to treat of divine worship. Here we are only desirous to shew what the end of creation is, and to prove that it exists primarily for the Infinite or the Creator; and that everything in the created universe tends thither.

§ XV.

There are many secondary ends.

But lastly, if the primary end be infinite, and terminates as it begins in the Infinite, for whom alone the world was created, are there not other ends also for the existence of man? Was he not meant to enjoy the earth as a possession? to enjoy human delights? For what else are his senses given him? or why do his delights penetrate to his very soul? Is he not designed to live after death in blessedness greater than the earth can afford him? All this I do not wish to deny, nay, cannot deny. But I have been speaking only of the primary end, which is not finite, but infinite; not for man, but for God himself. Therefore in what has been said it is by no means questioned that there are numerous secondary ends. All primary ends, before they are obtained, divide, by means, into many secondary ends in the finite sphere. I maintain, however, that all these secondary ends conspire to the primary end; and are necessary as ways and means to it. And as there is a divine principle in the progression of the final cause, it is impossible but the middle causes, and above all the last effect, which embodies the final cause, should themselves participate in that cause. Let us instance the human senses, and the delights that we receive by them. Now unless we had senses, and their exercise was attended with pleasure sufficient to cause all the harmonious perceptions of sight and hearing to affect the soul with vivid delight; unless sight and hearing were ends; and unless the soul's delighting itself with them, and with their harmonic recipiency of the creation, were again their end,—unless, we say, this were the case, the primary end would never be attained. The privilege which is possessed by the soul, united to the body by the tie of natural harmony, of being carried away, in fellowship with the body, with new delight, and with added freedom, into the knowledge, adoration, and love of God, is a means to the primary end. In truth, there is nothing in the world that is pleasurable to the senses, but becomes superlatively delightful, if the thought of God is in its enjoyment, converting all things into still more exquisite delights; which the subject will perceive if he be connected with the first cause. Furthermore the soul, as it is bound up with the body, requires to be instructed by the senses, to enable it thereafter to instruct the body, and both to tend to the primary end. So also whatever lies in the body tends to that end in the same manner. Man's possession of the earth as his own tends again to the same end; we mean, the circumstance that he is nourished upon the earth; that he lives on its surface; that his senses and soul are schooled by it, and he is taught the better to acknowledge God and the infinite, and through this acknowledgment, in conjunction with faith, to become a partaker of the primary end; yet only as the ultimate means, for the primary end lies in the infinite, and the secondary ends in man, terminating in him as a finite being; although by the acknowledgment, thought, and love of God, and the pleasure experienced in the thought and worship of him, man himself becomes a partaker, though only, we again repeat, as a means—of the primary end. It may therefore be said, that nothing can be or exist in man, or the world, that does not tend to that one end; so that in this way there is nothing, whether dead or alive, but adores and worships God, since all things tend to obtain the divine end in the ultimate effect. And oh! how greatly happy would man be, if he directed thither all worldly delights, and all the gifts of the mundane sphere. What a soul would he form! What a subject of everlasting happiness, ineffable in its delights, as perpetual in its aspirations to the end of ends! It has seemed good to the supreme and infinite Deity, that for all ends in all living subjects delight of some kind shall always be the impelling cause to the final cause: what some call pleasure, but we prefer to term it natural delight. In every animal there is this impulsive element, which spontaneously drives and incites it to peculiar ends. There is one delight which impels it to nourish itself; a delight received through all the senses impelling it to live; a delight which attracts it to procreate its kind; and a delight which causes it to rear its offspring. From the natural delight, therefore, in every case, we may conclude unfailingly to the end for which the subject was created. In man there is a similar natural delight, which drives, incites, and carries him to all his natural ends; viz., to live as lord of the planet, to nourish his body, to propagate his species, and to rear his children. Now the single incentive in all these acts is some particular pleasure or element of delight, which in one case is denominated taste, smell, or sight; in another, desire, love, parental affection, glory, or by numerous other titles; the source of all, however, consisting entirely in the pleasure and delight of which we have spoken; and the source of the delight, in love, while love itself depends upon connexion or harmonic contiguity. Therefore we are naturally incited to all our ends by some element of delight, the extinction and death of which is on this account so contrary to our nature. But let us come to the primary end, to which, as to other ends, we are led, in part sensibly, in part insensibly, by a peculiar element of delight. Now this delight is far purer, more delicate and strong, than any of the causes and delights of the other ends, and often actually overcomes them all; for it embodies whatever of superlative perfection is possible in delights; so that men often aspire to it athwart the extinction of all their other delights; nay, for its sake desire death itself. Thus we see that as all secondary ends tend to the primary end, so human delights are not really at variance with it. Also that every natural delight, once commenced, increases of itself by use and exercise, expanding in a progressive ratio, and spontaneously attains its climax; after which it spontaneously declines, and diminishes in a similar ratio, until at last it is self-consumed. In some men, indeed, it is so excessive, as not only to consume itself, but even the very body also, before it reaches its climax. The delight, however, that tends to the divine end, inasmuch as it dwells in finite parts, has its origin indeed at the same time as reason, and has also its increments and its degrees; yet we see that instead of reaching the highest degree, and then declining and diminishing until it vanishes away, it ever tends to the very acme of perfection, up to the hour of death, when it ought to be present *in all the* perfection of which it is capable. It therefore nears and nears the summit to the end of this life. And here be it observed, that we cannot now argue the question, whether the rights and laws of nature in human society are only to be regarded as means for its preservation,—whether, in short, the maintenance of society is their only end,—or not. The subject would be out of place at present. Supposing it decided in the affirmative, it will still follow, that these means are proportionably perfect, and most in accordance with reason, when they so regard the economy and preservation of society, as to make it a means to the primary end, or to any secondary end which tends either mediately or immediately to realize the primary.

Having fairly arrived at this stage by the resolution of the question of cause, we are now for the first time in a condition to institute the question of *quality*. For observe what we have gained. We have the affirmation of reason for the existence of God, and also for his infinity; and as this is now positive knowledge, together with that other truth of the existence of a nexus between God and man in the person of the only-begotten Son, so we may legitimately advance, not indeed to enquire into the nature or qualities of Deity, because he is infinite, and his qualities therefore we can never penetrate; but to enquire what there can be in man to lead to this primary end; what there can be in him that does not repugn the infinite and the nexus: how a confessedly infinite Deity may best be expressed in finite terms that shall not be repugnant to the occasion: what befitting worship consists in; what is the peculiar efficacy of faith proceeding from a true acknowledgment of God; with innumerable other subjects, which cannot be settled briefly, but require to be rationally deduced in a volume by themselves. And as, by the grace of God, we have all these matters revealed in Holy Scripture, so where reason is perplexed in its apprehensions, we must at once have recourse to revelation; and where we cannot discover from revelation either what we should adopt, or in what sense we should understand its declarations, we must then fly to the oracle of reason. In this way natural theology must proffer her hand to revealed, where the meaning of revelation seems doubtful; and revealed theology must lend her guidance in turn to rational theology when reason is in straits. For revealed and rational theology can never be contrary to each other, if the latter only be truly rational, and does not attempt to penetrate into the mysteries of infinity; in which case it is not truly rational.

CONCLUSION: Let us now define the meaning of the terms *natural* and *divine*, as contradistinguished from each other; for some mistake the divine for the natural, and some, on the other hand, the natural for the divine. In general, by natural or material we mean all that of which we see the effect in nature, and likewise the cause, instruments or means. Thus machines and their motive powers are mechanical and natural, because we see the instruments of motion, the wheels, the levers, the pulleys; and also the power accruing therefrom by mechanical laws. In the elemental sphere we consider it *natural*, that the vapors of water drawn up from the earth are condensed into clouds in the upper region of the air, and descend in showers; that storms arise; that the sun enlightens the world with his rays, and cherishes and warms it; that the ocean ebbs and flows at regular intervals. And the causes of these events we regard as natural, because they recur at stated periods, and because in time we may be enabled to comprehend that the means which produce them are in visible nature. It is natural in the mineral world for fire to melt metals; for mixtures of certain liquids to war, effervesce, fume and ignite; for different metals, in certain proportions, when immersed in appropriate liquids, to form what are called philosophical trees, [as of zinc, lead, &c.]; for the magnet to attract iron, and turn to the pole. Not to mention numerous other circumstances, which, as we know that they arise from visible substances and matters, and at the will and pleasure of human workmen, we term natural and not divine. In our animal kingdom sight is natural; also hearing, feeling, the growth and expansion of our limbs and frames; old age; the pain which wounds inflict upon us, and the state of disease which follows them; death succeeding either poison or the sword: all these effects come under the designation of *natural*. So again the motions and sensations of living creatures, whether external or internal, are denominated natural instincts, and the whole animal being is organic. As to those other matters of *which we* know nothing, and which are transacted in that purer sphere from which all the modes existing in compounds derive their principles, some persons would have them named divine or spiritual. In my judgment all that exists from the primitive seed of nature to her largest compound, including the whole world with all its parts, and the origin and motion of its parts, and the innumerable modes proceeding therefrom, in a word, the totality of the finite sphere, all—all is natural. But yet there is nothing natural but is divine. The only difference is, that the primitive is made natural by God immediately, while the other substances successively arising and subsisting from it, are made so mediately. Thus whatever we term natural is mediately divine: for it comes through finite means from the primitives, and consequently from the infinite, who is the cause, fountain and origin of all the parts as well as of the whole. Therefore nothing exists, subsists, or is made, but derives its origin and cause from the infinite, without whom nothing can exist, nothing can subsist, nothing in the universe can be, or can be made. For nothing exists but from causes and causes of causes, and consequently from the first cause, that is to say, from the infinite. In this respect God is all in all, and there is nothing conceivable without a beginning and cause in the infinite, provided always it be not repugnant to him, no matter how low it stands in the finite series. But to call the cause, origin and effects of anything in the subtler or grosser field of nature, which exists mediately through other finite things, immediately divine, would be tantamount to finiting God, or making him similar to the finite being; and consequently to denying his infinity; or to forming and fostering a gross, natural and idolatrous idea of the infinite Deity; which is permitted to no one; least of all to Christian philosophers.

Analogical instances illustrate, although they cannot demonstrate. Thus by the comparison of the soul and body it seems possible to gain some little light respecting the connexion of the infinite with the world. Apart from the soul there is neither action, passion, life, nor intelligence in the body. The immediate effluence and minister of the soul is that analytic, philosophical and distinct rationality by which we are distinguished from the brutes. All the remaining operations are the property of the soul, although only mediately; for example, all instincts, appetites and pleasures: and all confused states of thought and feeling, and perceptions of hearing and sight, are equally referable to the soul, however they involve the instrumentality of the bodily organs. In short, all sensibility, wherever located in the body, owes its very existence to the soul. The law of action, passion, or sensation, wherever they exist in any contiguous organization or volume, requires them to begin at one end, or perhaps in the middle, and to terminate at the other end. Nothing can exist within the field of any contiguous and connected entity, without coming into relation with its ends or boundaries: nothing, therefore, can exist within the microcosm of the body, without being referred to the soul, where it becomes sensible in the first place, and at last intellectual. And in the same way nothing whatever can exist in the macrocosm of the world, but is referred to the Infinite; without Whom there is neither existence nor subsistence; for in Him is the source, cause and end of the whole universe. And yet there is nothing immediately divine save only that one thing which is either purely simple or primitive, or next thereto and superlatively perfect. All other things are mediately divine, because, both in point of existence and subsistence, they stand related to their principle mediately, by the way of connexion and contiguity. And hence without the infinite there would be neither activity, life, nor intelligence in any subject in the world, and above all, neither existence nor subsistence. But if the reader should choose to adopt a different argument, proceeding by induction, he may, if he please, reason of the infinite from things in the finite sphere. Thus he may say that excepting the first or smallest substantial there is nothing in reality substantial in any finite subject; for whatever exists is composed of the smallest substantials. Or he may go further, and declare, that there is nothing in finites but the pure simple, inasmuch as all things have had their origin from pure simples. Yet whatever inferences we make in the way of analogy and comparison from finites to the infinite, conduce to illustration indeed, provided they are not contradictory to the case, but they in no wise help us to form an analytic induction in a finite and geometrical sense. All modes, and analogues of modes, and of such it is that analysis is formed, begin in the simple or primitive of nature, and not in the infinite, in and from whom, nothing can be said to exist, or issue, immediately, by any mode which is intelligible to us in any geometrical, analogical, rational, or philosophical sense whatever.

CHAPTER II.

THE

MECHANISM OF THE INTERCOURSE

BETWEEN THE

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Is the soul finite, or infinite?

At the outset to an enquiry into this subject, we are met by the general questions, of, Whether the soul be finite, or not? And whether the animal spirits, as they are commonly called, be finite, or not? To which we answer, that no one can deny that the soul is finite, and that its spirits* are also finite. There is nothing infinite but the one only God. Whatever is not infinite must be finite, or analogous to finite. No middle term is possible; no essence partaking of both; but the finite is by itself, and the infinite by itself, or the nexus between the two is infinite. As then there is no compounding of the finite and infinite, but the one is as nothing in relation to the other; and as there can be but one infinite, and that one is God; so the soul cannot be infinite, because it cannot be God: therefore it is finite.

Is the soul amenable to laws?

But another question arises, namely, this: If the soul be finite, and consequently created by the infinite, is it amenable to laws? or is it independent of laws, and the first being that is without them, but which, on this very account, by virtue of its own innate force and activity, can give laws to lower and grosser things? We answer that if it be finite, it cannot be devoid of laws. Apart from quality the finite has no existence. Quality attaches to all finites as an inalienable attribute. Whatever becomes finite must, as such, have a peculiar character of some kind; which character or quality must also be finite, or be finited in a certain manner, and be amenable to certain laws. The finite devoid of quality is tantamount to the infinite. Quality cannot exist without laws, without discrimination from other quality, without difference, without distinct capacities for action and passion. Moreover if the subject is finite, all the predicates must be so likewise. And if the finite has modes, then at any rate there are laws by or according to which it has them; which alone is sufficient to shew that it cannot exist without laws, which indeed must be similarly finite with the subject itself. Nor is there any doubt that the soul has its own laws, inasmuch as its main quality consists in its operation on the body and the organs which compose it. Whether, however, this operation is mediate or immediate, is a question we do not discuss at present. But as the soul is so connected to the body that it can communicate its activity to no other body but its own, and can impress it upon no other, so at least it is undoubtedly subject to one general law, namely, that whereby the power of communicating itself and its qualities is limited to one particular system. And as it is thus bound to the body, operating upon one part of it at one time, upon another at another, and distinctly accommodates its operations to the formation of the body, and of the parts which compose it; and as it is often unable to dispose that body and those parts at its will and pleasure, being on the contrary obliged and enabled to adapt itself to the position, form, and motion of the body and the parts: so we see, that not only in itself, but also in the peculiar laws which it enjoys, it is so endowed that it can adapt itself to the body, whatever the nature or state of the latter may be; and in this respect assume as it were a different identity, not always confining its operation to one method; or as we may even say, it can submit to be formed afresh by new conditions, and to operate on the members of the body by itself taking upon it their likeness, or harmonizing with them; while yet it operates in such a manner that these members obey its operation. And thus we perceive that the soul also has a QUALE, in that it can be such or such a soul, or become such or such an one, and operate not only upon parts like itself, but also upon a succession of other parts which are *less* and less so. From which circumstances we can only deduce, that it has in it a quality, faculty or power of operation, in conformity wherewith it possesses laws, by which it governs, and is governed. Nor need we dwell longer on the point. For it is impossible to deny with reason that the soul is finite, and therefore has laws of its own, by which it operates upon the body.

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* Spiritus *animales*=the spirits of the *anima* or soul.—(*Tr.*)

Are there any but mechanical laws in finite things?

The next question is, are there in finites any laws but such as are mechanical, and admit of geometrical definition? We do not here propose the question, whether God could have created a finite nature different from that which can only be finited by our mechanical laws, and consequently by geometry. For to God, who is infinite, nothing is impossible. But seeing that God has chosen to finite, and to produce a finite nature; and seeing that that nature, obviously to the senses, and in its more considerable parts and effects, is finited in a given manner, in other words, is mechanical, and subject to the laws of geometry; seeing this, we say, our question simply is, whether in her least parts nature be finited otherwise than mechanically or geometrically? Before we can answer this enquiry, let us observe how nature is finited in her gross compounds and her low and remote derivatives. Now in all the objects perceived by the senses, we see that there is nothing but is mechanical, but has mechanical powers for its laws, which laws are founded in geometry. We remark this in compounds; and cannot therefore deny that so far all is mechanical and geometrical; for we either do, or may, gain this primary information by the senses: and on this very account can have sensual experience of motions, distances, and figures, and measure them accordingly. We now proceed to those other existences which are internal to the sphere of the senses, and of a more subtle nature; and we affirm that there is nothing in the gross, large or sensible world, but derives its cause by a successive process from the subtler world; for all effects proceed from their own peculiar causes. But the effect, issuing, as it does, from its causes, cannot fail to be similar to them; for it derives its very beginning—its principle of identity—from those causes. Therefore the very principles of things pass from causes into effects. And since, as we have seen, all visible effects are mechanical, what else can we infer, but that there is the like principle in causes too; and that even in them the mechanical and the geometrical are present? Were there not the same principle in causes, in the subtler world, as in effects and the grosser, the effect must become absolutely unlike its cause; or else there must be something in causes over and above what was manifested, or what came into effects. But this is neither rational to suppose, nor accordant with experience. An analogous principle to what we perceive in effects may or should be involved in causes; a principle which, allowing for the difference of sphere, admits of being inferred from the effect. Indeed there are many things apparent to our senses, whose causes, causates and effects we see and feel; so that before our senses even we have both effects and causes. When we are desirous to reason of causes from experience, and to shew how they concur to form effects, we can have no better method than by considering those causes which we see in palpable combination, and in the same plane, with particular effects; in instances, that is to say, where both causes and effects are comprized within one and the same sensual sphere. Now in all these cases we have observed that there is a mechanism; *i.e.* that there is a mechanism in the effects, and that there is a mechanism in the causes: and this we continue to observe until the causes become so subtle, that they at first begin to disappear, and at last actually disappear from our senses. At this last juncture we find that we desire to deny mechanism to the vanished causes. It is, however, no sufficient reason against their mechanical nature, to say that it is not sensible: it may be perceptible notwithstanding, and plausible too, when we reason inductively from those objects that lie within the province of the senses. To reason thus would be no more than if we should say, I see that an animal moves its members, as its head, feet, loins, and limbs; and it also moves their different parts: I see mechanical effects in its larger subdivisions: and I see by dissection that its mechanical movements depend for the most part on the muscles, which are themselves adapted and formed to produce a mechanism of the kind. We have ocular demonstration of a thousand figures designed for such motion, and likewise of numberless species of bodies formed with no other view. We can shew the arrangement of fibres necessary to produce it. We can take the muscles and other parts in our hands, and set them in motion, during which we shall see, that the manner of their motion is not and cannot be different from the actual effect, that is to say, from the action of the moving member. We may take a separate fibre or any other part, and demonstrate its flexibility to the senses, and its power of contracting and dilating in combination with the associate parts. Therefore we see causes and effects with our eyes, and recognize mechanism in both, and geometrical adaptation to mechanical motion. And if we make use of the microscope, we shall see the lesser parts as we before saw the larger, and observe in the lesser the causes which produce the motion and extension of the larger. But when the parts begin to disappear, and we no longer see them either with the naked eye or the microscope, what are we then to think? Are we to say, because they are hidden from the senses, because the causes are unseen, that they are not equally subject to mechanism or geometry? Granting that a thing is possible because we can see it, it by no means follows that its existence is impossible because we cannot see it. It is more feasible as well as logical to suppose, that in the lesser sphere, or in causes of causes, nature is the same as we see her in causes and effects. That such is the case we may infer, continuing the same process of reasoning, from the case of insects, some of which are so small as to be invisible to the naked eye, and yet under the microscope we not only see them, but also perceive that they are capable of motion, and possessed of members. Yet if their members were beyond the power of the microscope, as sometimes they are, would it be right to conclude that they had none; or that if they had, the members were destitute of muscles and fibres, and all analogous structures, whereby the motion of the parts, and by a just succession, that of the whole, is provided? What reason would there be for denial? The circumstance of not seeing is no reason at all. The seeing and hearing sense is given us, to comprehend certain effects and causes; and a soul is given to these senses, and a reason thereby, to infer the nature of the causes and effects in those things which we neither see nor feel.

Is the finite conceivable apart from extension?

Is the finite conceivable apart from extension? At this stage it is particularly necessary to our argument that this intricate question should receive a plain answer. Let us see, therefore, whether every finite thing must not be natural also; whether every natural thing must not have peculiar laws; and whether all the laws of nature, both in her least and greatest, and in her invisible and visible spheres, must not be mechanical and geometrical. We have hitherto endeavored to prove by visible causes and effects, by induction, and in short by reason proceeding on the ground of analysis, that all natural connexion between things would be impossible unless there were the like principle in causes, as in effects, and consequently the like in causes of causes. Proceeding onwards let us take any finite, for every created thing is finite, every natural thing is finite: and the question will be, whether every finite is natural, and natural in the same sense as, and with the same qualities that we recognize in, the visible world? Tell me then, is it possible to conceive the finite without extension? Were it devoid of extension, and of all analogy with extension, must it not be infinite? At any rate can you conceive that there is anything devoid of all analogy, or resemblance of the kind, and which derives absolutely nothing from extension? Whatever is finite, and everything natural is finite, is utterly inconceivable without extension; at all events without analogy or connexion with extension. I here speak naturally, for it would be against all reason to fly at once to the infinite while professing to investigate nature; the more especially as we have causes of causes in the finite sphere, and as nature once for all has been made finite by the infinite. However, even granting a finite that is not extended; granting the possibility of a finite whose peculiar nature does not lie in its precise extension, yet still it is undeniable that it must involve something like extension; otherwise it could neither act with, nor in, nor upon extension. But let us willingly adopt the position, that everything is extended in proportion as it is finite; bearing in mind that we are now speaking of substances. In proportion, then, as it is extended, in the same proportion it occupies space; which be it as small as you please, still is space notwithstanding. This being the case, it is inconceivable without attributes; for nothing finite is without them; which attributes indeed can in no way be separated from their subject. If the subject be extended, *one* of its attributes must consist in the possession of figure or form. Extension or space without form is a nonentity, or a notion contrary to reason. Extension combined with form is a geometrical subject. Geometry simply considers extensions and spaces with particular forms, or forms in their subjects. But can there be form in extension without its having a geometrical import, considering that the extension is finite? In proportion therefore as the subject is extended, it is also formal, or contains the element of form; and in proportion as it is extended and formed, it is also geometrical. Let us now proceed to the mode or motion of a formed portion of extension. Motion may exist in any space or extension if the latter has parts, in which case a motion of the parts is possible to a given place in the extension; *i.e.* a local motion of the parts. If the extension has no parts and still undergoes motion, in this case the formed extension must itself move from place to place. If it consists of parts, and all the parts compose the given extension, and all, therefore, move together, in this event we have a motion of the whole. In short, the extension may undergo motion either as regards the parts or the whole. And if it undergoes motion in any way, the predicament is mechanical. The motion of an extension, of whatever description the motion is, cannot be other than mechanical; for mechanism embraces all motions, and all the forces resulting from them; no matter what their nature is, provided motion be present at all; or mode be present, which cannot take place but by motion: consequently the fact of motion and mode is mechanical. Now again comes the question, Whether the laws of motion affecting the simpler and smaller bodies be as the laws of motion affecting the larger; be, in one word, mechanical? And here we affirm generally, that there can be no motion of an extension, or of any parts in an extension, but such as comes under the denomination of mechanical; for all mobility is mechanical. But if the subject moves, or is capable of motion, and thereby is mechanical, then we ask, can motion be considered apart from figure? Assuredly it would be contrary to reason so to consider it. If the path of the motion be a straight line, still the predicament is geometrical, in so far as a linear or straight progression is involved in the case. By the same rule, if the motion be circular, the result is geometrical, and figured likewise. If the motion take

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Is the soul's pure simple? But as we are treating of the soul, let us see whether we can rightfully conceive of it as a pure activity; as a simple* of such a nature as to be devoid of geometry and mechanism. For if it be a pure simple, it admits of no degrees. The essence of the pure simple lies in absence of parts, in consequence of which it is destitute of extension, space, dimension and figure. If the simplicity be so preëminent as to exclude all further simplicity, it must of course be wanting in parts, space and figure. Where parts are present in a simple, we have at once a simpler; each part being simpler; wherefore the pure simple has no parts. And if it have no parts, and admit of no deeper simplicity, then it is an unlimited essence, without end or boundaries; unless we choose to say, that it has one limit or boundary, and only one, inasmuch as it has the power of giving limits or boundaries to compounds. For every portion of extension arises from what is less extended, and at length from what is simple or not extended. In like manner every figured subject arises from what is simple or not figured, in which nothing but simplicity is conceivable. Nor can a simple of this kind, involving neither parts nor extension, be denominated finite; for there are boundaries in the finite; those, namely, by which it is finited or limited. With such a simple, the soul, which is finite, and bound in allegiance to finite laws, bears no analogy. This pure simple, being devoid of parts, is indivisible; and to divide it, is to annihilate it; for when no form. Extension or space without form is a nonentity, or a notion contrary to reason. Extension combined with form is a geometrical subject. Geometry simply considers extensions and spaces with particular forms, or forms in their subjects. But can there be form in extension without its having a geometrical import, considering that the extension is finite? In proportion therefore as the subject is extended, it is also formal, or contains the element of form; and in proportion as it is extended and formed, it is also geometrical. Let us now proceed to the mode or motion of a formed portion of extension. Motion may exist in any space or extension if the latter has parts, in which case a motion of the parts is possible to a given place in the extension; *i.e.* a local motion of the parts. If the extension has no parts and still undergoes motion, in this case the formed extension must itself move from place to place. If it consists of parts, and all the parts compose the given extension, and all, therefore, move together, in this event we have a motion of the whole. In short, the extension may undergo motion either as regards the parts or the whole. And if it undergoes motion in any way, the predicament is mechanical. The motion of an extension, of whatever description the motion is, cannot be other than mechanical; for mechanism embraces all motions, and all the forces resulting from them; no matter what their nature is, provided motion be present at all; or mode be present, which cannot take place but by motion: consequently the fact of motion and mode is mechanical. Now again comes the question, Whether the laws of motion affecting the simpler and smaller bodies be as the laws of motion affecting the larger; be, in one word, mechanical? And here we affirm generally, that there can be no motion of an extension, or of any parts in an extension, but such as comes under the denomination of mechanical; for all mobility is mechanical. But if the subject moves, or is capable of motion, and thereby is mechanical, then we ask, can motion be considered apart from figure? Assuredly it would be contrary to reason so to consider it. If the path of the motion be a straight line, still the predicament is geometrical, in so far as a linear or straight progression is involved in the case. By the same rule, if the motion be circular, the result is geometrical, and figured likewise. If the motion take any other course or shape, provided only it passes from one place to another, this is at once tantamount to its passing from one boundary to another, and thus the motion becomes geometrical or figured. We may conclude from these and a multitude of other arguments, that there is nothing in the nature of things,—in so far as their nature is finite, and endowed with qualities and modes,—but has its own peculiar laws; and likewise that in our natural sphere,—in man as a natural being,—there are no laws possible but what are geometrical and mechanical.

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* Respecting the terms *simple, active, finite, element*, &c., the reader is referred to the author's *Principia*. By consulting the Index to that work, he will obtain an insight into the usage of these and similar terms in the present Treatise.—*(Tr.)*

Is the soul a pure simple?

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Is the soul a simple finite?

But as the soul is thought to be a pure and simple activity, and at the same time to be finite, let us see whether it is identical or not with the simple finite. The simple finite is not the same as the pure simple, inasmuch as it is finite, which the pure simple is not. And being finite, it is of course made so by constituents simpler than itself. The before-mentioned simple is therefore simpler than it, and consequently the first finite is relatively compound. If simpler things than it exist, then it cannot be purely simple, because it admits a higher simplicity. Thus the simple finite supposes a mode by which it is finite; it supposes boundaries to which it is limited; ends for which it is finited; it supposes a peculiar nature through which it is finited, and this, in its own contradistinctive manner. And as the pure simple is devoid of parts, extension, space and figure, and yet parts, extensions, spaces and figures had issued from it; so this simple finite could not originate from any other source than the pure simples, which made it finite. On this account the *simple finite* cannot be said to be altogether devoid of parts, since the simpler grounds may be conceived to be its parts, or to be such as to yield or generate parts, either by the process of multiplication or some other mode. Therefore it cannot be regarded as entirely without extension and space, though it is the least and smallest thing in space, the very smallest possible substantial or natural principle. Nor can it be said to be indivisible, for it admits of division into the simpler grounds we have before spoken of, and therefore may be divided without being annihilated. In a word, before it obtains its boundaries, it obeys modes in its origin; and consequently in its existence and subsistence also. Can the soul, then, be a simple finite of this kind? The soul cannot be conceived apart from activity. Its essence consists in its activity; in its ability to act upon the parts of the body; and of its own body exclusively. Unless therefore we regard activity as involved in the simple finite, the latter is not identical with the soul. The activity of the pure simples in such finite, must either be an activity among the parts constituting it, or else an activity of the whole. If internal or among the parts, it would not follow that there was any activity among other parts extraneous to itself. If, on the other hand, it be an activity of the whole, this cannot be conceived without activity in place, or local motion. Without local motion, no force or action can be exerted on adjoining bodies, and no change can be produced in them. If the activity were simply effort to motion, no bodily action or force would ensue, that is to say, unless the effort resulted in local motion. We have therefore to conceive that the simple finite is active not only intrinsically or in its parts, but also as a whole. If then there be activity both of the parts and the whole, and that of the latter be local, the motion itself at once becomes finite, not only as taking effect from one place to another, but also because the essential which undergoes the motion is finite. No essential finite can produce a pure or total motion. Action supposes not only force or effort, but also velocity and time. Therefore the activity in this least substantial, is finite, and in nowise pure or total. Purity exists in the pure simple alone.

Is there passivity in the soul as well as activity?

But assuming that the soul is a simple, a pure, and a most perfect active; finite, however, in its simplicity, purity and perfection; it remains to be seen how this predication would coincide with its *essence* and attributes. If the activity of the soul consists in these, it must necessarily be such that it can act upon the parts of its own body exclusively; that it can suffer and receive the motions or modes arising from the body; that it can dispose or adapt itself thereto; and afterwards reflect them, and meet the forces acting upon it by a corresponding reaction, so as to be adapted at least to produce such modes, and this, within the sphere and space of the bodily system. If the soul were merely an active of this kind, it might indeed act, but it could not be in itself sentient of the actions of the body, nor dispose itself for reception at the same time as for action, nor modify itself to the different parts of the body. The complement of its essence requires then something beyond pure activity; in short, a passive principle, adequate to enclose or shut its actives in a definite space, or, if we may use the expression, in a passive expanse; whereby it may not only be enabled to act on the body, but also to receive the actions arising from the body; also to adapt itself to the variety of modes, and reflect them back again; a passive principle, we repeat, in which the soul may be able to exert its actuality and power; and which, in a word, will ensure passivity to the soul as well as activity. In this manner the soul is a sentient subject not only during the life in which it is conjoined with the body, but even when it is out of the body: after its release from which, it remains capable of doing and suffering still, of action and passion, of perceiving degrees in delight, and of living without the possibility of dissipation. But none of these circumstances can be conceived without passives in the soul; nor passives without an expanse; nor an expanse without a figure; nor active and passive together without space and extension; nor the required extension without elasticity; nor consummate, genuine and primitive elasticity without actives enclosed or shut in a given expanse; actives which will act perpetually upon the expanse; but are incapable of forming a contiguum like that produced by elementary particles; also of occupying place, or capable only of occupying such place as the expanse allows; actives to whose motions the predicates of upwards and downwards are inapplicable, but which act at all angles and in all directions, and cannot therefore be said to resist, but simply to act; not to mention a number of other predications, on which we shall dwell at another opportunity*

§ II.

Is the soul bound by geometrical and mechanical laws?

We now come to the final question, viz., Whether or not the soul be bound by geometrical and mechanical laws; that is to say, Does it exist, subsist, rest, move, and operate on the parts of the body, mechanically and geometrically; or the reverse? And here it is necessary to recur to the previous question, and again ask whether the soul be finite, or not; whether it be created, or not? The affirmative of this is not denied; for no one can declare,—no one can have any motive so far to contradict reason as to declare, that the soul is other than finite. For it is created; it dwells in the world; in this respect it is a part of the world; it operates in a finite manner upon the natural parts or members of the body, *i.e.* upon the body; inasmuch as the body upon which it operates is composed of parts. As surely therefore as it is created, and dwells in the world, and exerts its actions upon confessedly corporeal and natural parts; so surely must it be admitted to be finite. A further question now suggests itself, namely, Is the soul natural, or not; that is to say, is it a part of nature, a part among other parts? We answer this in the same manner as the previous question. As the soul is created and finite, and as God created the finite, that is, nature, hence the soul cannot be otherwise than in nature. But is it natural, or not? It is clear, indeed, that it is in nature, and was sent into nature by God together with the world, and that therefore it is one among the parts of the created world; also that it is not without or beyond the world, and that it is not infinite; that it admits of being enclosed within the finite, that is, within the body; and that therefore it is attached to the parts of the body. Were it infinite, the latter circumstance would be impossible, but the soul would be a separate essence from the corporeal parts, and would lie both without and within the body. It is, however, clear from experience altogether apart from reasoning, that the soul is a real constituent part in the body, and is attached to the body, and consequently is not infinite, but limited to the body; and therefore one of the natural parts in the body. And thus we obtain a directly affirmative answer to the enquiry, Whether the soul is a part among the physical constituents of the human body.

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* For information on this subject, see the Index to the *Principia*, under the head *Active*.—(*Tr.*)

As then the soul is natural or physical, is it simply under the laws of nature? or has it other laws of which we are, and for ever will remain, in profound ignorance? We answer that according to our former conclusion, whatever is natural must come under finite laws; otherwise it would not be finite, but infinite: therefore the soul is under laws, and can and must operate according to them. But what laws? Have we a right to suppose that we can never penetrate them? On the contrary we may recollect that we have proved above, that our natural or physical sphere admits of no other than the very laws which appear in actual effects, of no other than geometrical and mechanical laws; geometrical in regard to figure and space; mechanical in regard to motion and force. If any one can point out to me,—I will not insist upon demonstration,—but if any one can point out, how any other laws than these are possible in our finite system, I will cede the whole argument. But as it is impossible to conceive any finite existence without extension; or extension without form; or extension and form together, where motion is performed, without mechanism; or mechanism without figure; so I am utterly at a loss to know how it can be shewn that there are any other rules or laws of nature beyond such as are geometrical and mechanical. And when I assert the coexistence of mechanism and figure, it will in no way impede the argument, if the reader shall declare that he can conceive many things without extension; that he can conceive modes, modifications, contingencies, time and the like. For I assert that he cannot conceive any of these in the abstract, or apart from extension, for that they all are produced by the modifications or motions of extension; and therefore are referable to finite extension, together with all in them that comes under the designation of succession, degrees and moments: hence they too are in this respect extended. I am, however, well aware that any one who chooses to deny extension, denies also the geometry and mechanism of nature. But then whoever denies extension, denies the finite also. If, however, he can shew how the finite may still exist, without extension, succession, degrees, moments, and similar predicates; and that it does not take its rise from extension, I will cheerfully pass over to his opinion. But if the soul be created, finite and natural, (for God would never create two kinds of finites or two naturals, unless to concur to some similar end, in which view they may be considered together as one natural,) and subject moreover to the laws of nature, then there is no escape from the consequence, that it is subject also to mechanical and geometrical laws.

The comparison of the soul with machines, — in what sense justifiable?

But if the soul is mechanical and geometrical, it may be difficult perhaps to explain many of its faculties, as imagination, perception, the power of conclusion, memory, self-consciousness as it is termed, the ideas of reflexion, &c., &c. On this subject, however, we would observe, that we may receive at all events some little light from the vast field of the animal kingdom;* and also from the subjects of the brute creation, which both have life, and breath, and animal functions, and in which we find senses similar to our own, as well as similar motions, and a similar configuration of the parts and the whole. It is true we do not find in them reflexion, imagination, memory, or rational analyses such as we perceive in ourselves: but nevertheless we see parallel traces of these faculties. At the very least we may remark in animals some similar endowments, some confused and rude symptoms of our own powers; some endowments which we are content to denominate natural instincts, considering them as an organic condition, and in point of fact as a machine. If then we conceive these predicates as more pure, perfect and distinct in man—if we conceive that all these analogous and parallel faculties in him exist with reference to a more distinct, perfect and pure principle or end, in a word, to a soul; whose comparative distinctness, perfection and purity do not make it any the less mechanical in its purity and perfections; in this case mere difference of perfection does not involve the putting aside of all the laws which exist in the purer field of mechanics, and in the purer world. So that if the reader would speak of the soul by comparison with machines, I have no objection to respond in the same tone; only I cannot allow the comparison with inanimate, but with animate machines. But on this subject I shall speak in detail in the work to which this essay is preliminary.

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* By the *animal kingdom* the author appears here, as in his other works, to mean the *human* body exclusively: see our Introductory Remarks to the *Economy of the Animal Kingdom*, p. xxxii.—(*Tr.*)

Is the soul immortal?

But as we declare that the soul is subject to mechanical or geometrical laws, it may be thought that it is not spiritual but material, and therefore will die with the body. Such a view, however, can only arise from a very gross idea of the purer mechanism: otherwise it could never be supposed that the soul will perish like the gross materiality and organization of the present body. For if we consider that on the one hand we have a gross, imperfect and mutable world, and on the other a relatively pure, perfect and immutable world, it will not seem likely that that finer world, near, by its very conditions, to the primitive substance, should perish with the grosser. Whatever is obnoxious to destruction and change, is on this account finite and substantial, or material; and has derived its mutability and imperfection successively, by its lowness and remoteness in the scale of creation. But the purer field—the finer, purer and more perfect world—is not thus obnoxious to change, nor thus imperfect. We should seem to go contrary to the Infinite, and to repugn the divine essence, if we said that the purer sphere, and the souls which inhabit it, were subject to those casualties of death, change and transformation, which affect the grosser. Whence we have reason to conclude, that the superlatively perfect finite, *i.e.* whatever is most perfectly finited, and dwells at the same time in the purer world, by God's grace is secure from destruction, and will never taste of death. For, as we before said, its immutability is in direct proportion to its perfection and purity. And if the soul be a portion of that world, then the most thorough self-similarity must pervade it and all its parts, in whatever they do or suffer. And if we direct our attention to the mechanism of those subtle parts of which the soul is one, we shall see that it cannot die without these minutest parts themselves undergoing destruction or annihilation: we shall see that it cannot die though the planet with its water and earth should perish; nor though the air nor the ether should perish. But were nature's subtlest sphere to perish, then not only would the whole finite universe, of which the soul is a part, be annihilated, but all things would return to nothing. The soul is immortal, therefore, by the grace of God, and by the same grace the universe is preserved from annihilation. There is no occasion to say more. In our intended Work we shall demonstrate the point as clearly as we are able, and shew that the soul is perfectly, and in the high sense, purely mechanical, and that it is immortal, and cannot perish without the universe be annihilated: likewise that it has been so created and formed as to begin to live in the body, yet never to die; and that it is naturally impossible that it should die; and that it can be harmed neither by fire, nor by air, nor by ether, nor even by any elements subtler still.

We said above, that philosophers have hitherto regarded the soul as a thing utterly and preëminently unknown, and destined so to continue to the end of the world, or at any rate till death, when the soul being released from the body may perhaps at last come to know itself, as we know ourselves, by the senses. Having regarded it in this light, and yet observing that it operates upon our mechanical organization just as one mechanical thing operates upon another, and concluding from this that the body and the soul must be so connected with each other that the former can do nothing without the latter, and without in fact previously referring all its intended actions to the soul as a centre; and seeing also that the will does not depend upon the body singly, but also upon the soul, in fact upon a reason and resolution the product of the two: seeing, I say, such a combined system of operations, the philosophers were unable to separate the one from the other, or to consider them as separate subjects, without supposing a medium partaking of both, this medium being the animal spirits, to perform the behests of both as ministers and emissaries in all parts of the system, and so not only to dispose but to urge the muscles and fibres to compress or relax the organs by one motion or another. It was on *this account that* they called these emissaries, "spirits," adding also the predicate, "animal," so as to have some words to express the medium, and at the same time to convey that these spirits were as thoroughly unknown as the spirit of man apart from the body. They selected the expression because they could not deny the nexus, and yet were in the dark as to its nature. They saw, however, that the one operated on the other as passive on active, or as fire operates upon material bodies; or as any other agent or efficient power operates upon anything for the production of effects. Nevertheless they denied that the animal spirits operate by any mechanism, or by any other but unknown laws foreign to all common and known mechanics. And whenever they spoke of the mutual operation of the soul and the body, they chose to illustrate it by a number of distinctions, and by terms borrowed from the scholastic philosophy: though nevertheless the whole matter remained equally unknown as at the beginning to both their readers and themselves. The conclusion was, that the active principle must be not material but spiritual, and that the spiritual principle must have the power to act.

Mechanical laws admit of superlative perfection as much as any other laws.

But what occasion is there to set ourselves up against the laws introduced, and given to nature by the infinite? Why may not the highest degree of perfection exist in them? Is a thing imperfect because it is called mechanical or geometrical? Are not the laws of mechanics and geometry derived from the infinite? Why should we reject them on the ground of inadequacy when it has pleased the infinite to produce by them effects perceptible to the senses? Why may they not involve a power of the same kind as those other laws which we suppose unknown, whereby the soul is governed? Why are we to leave our unknown quantity to posterity, which perhaps will not consider it as unknown? Why should we not be beforehand in the matter, and penetrate it with our science in the present age? We are like the rude and uninstructed inhabitants of some country, who are ignorant of the earth's boundaries, and do not even know that it has any, and although they see that the land does not end with their own parish, they think it must surely cease at no great distance beyond. And when in course of time they travel onwards, and come to some lake, or to the shores of the ocean, they cry out that they have found the end of the earth. Their posterity, however, having learnt the art of navigation, has found by experience that the end is not there; and at last they discover that the earth is round or oval, and that therefore they can circumnavigate the entire terraqueous globe. In short the children are more enlightened than the parents, and know the very thing which the parents declared unknowable, and gave up accordingly; and so they laugh at the simplicity of their forefathers. The same progress is exemplified in anatomy. For instance it used anciently to be thought, that the members of the body moved in some unknown way; that the ear heard in an unknown way, and that sound consisted in the organs of hearing, and sight, in the external organs of sight. Later enquirers, however, penetrated deeper, and discovered not only that sound arises from the undulation of the air, but also that the ear contains instruments of mechanical construction for receiving the undulation, and conveying it inwards. And in still more recent times the microscope has added new sharpness to the eye, and enabled our anatomists to discover parts which were altogether unknown to their predecessors. Moreover the more acute philosophers have made out, that neither hearing nor sight have a real existence until the undulation reaches the inner parts, and the senses themselves are taken into fellowship with the soul. Thus learning encreases by slow degrees. And as the learned world is continually engaged in exploring the mysteries of nature by experiment, there is no reason to despair of further progress, or of their ultimately reaching the soul, so as at all events to judge of its mechanical operation. Inasmuch then as the sciences are diving continually deeper into the mysteries of nature, and as continually detecting a resemblance between the substances of the subtler and grosser worlds, it seems just to believe that they may one day attain to knowledge on even this abstruse subject. And why not at the present day? so as to forestall our posterity, and prevent them from laughing at us as we ourselves now laugh at some of the old philosophers.

From ignorance of the state of the soul, we may easily pass to a denial of its existence.

We will not indulge in a recapitulation of the several opinions which have obtained on the human soul; for although nearly all the philosophers have considered it as a preëminently *unknown* essence, still they have been anxious, by one means or another, to demonstrate its connexion with the body. For when we are busied with the unknown, and do not wish to acknowledge its resemblance to the known, the result must be, that opinions and conclusions will arise which demonstrate nothing at all. On this account the greater number of philosophers swear by the animal spirits, explaining all the motions of the body by them, the soul, however, having command over them, and they executing its behests, and running hither and thither in the system, to perform their duties as servants for their mistress and queen. Some thinkers, however, and these not a few, although far from choosing to commit their sentiments to paper, privately and quietly consider, that doubt hangs upon the whole question of the soul, and that its very existence is problematical; for they see that it is impossible to regard it as a mistress sitting in her high chamber, with the animal spirits standing around her like servants, and flying quick as air to do her bidding: so that in fact they neither acknowledge the queen nor her government. Desirous, therefore, to explore the nature of the soul by reasoning, but unable to come to any solution, they leave it doubtful altogether. And as the passage is easy and short from doubt or ignorance to denial, so they tacitly deny the soul, and declare the materiality of whatever exists in the body, and of consequence the mortality also. Indeed, many half-philosophers rendered the subject one of doubt for themselves, until their position became so critical, that the faintest gust of reasoning was sufficient to tumble them into negative opinions. For when we are perfectly ignorant of anything, we naturally either recognize it as unknown, or else, if the clearest case be not made out for it, we rest in doubt and unbelief, persuaded by circumstances to the latter course. Moreover, when our reasoners consider the animal creation, they see that brutes have senses equally with man, and enjoy, in common with ourselves, the endowments of seeing, hearing, tasting, smelling, &c., &c. The interiors of their bodies also present nearly the same construction of parts, the same mechanism of organs. They have a cerebrum and a medulla oblongata, cerebral membranes, cortical and medullary substances, arteries and veins: in short, to the senses of such reasoners, animals have all things almost the same as ourselves. And what is more, some animals have acuter senses of sight, hearing and smell, than man. And when to this it is added, that something very like reasoning or understanding is observable in brutes, and furthermore that some men are but little different from brutes, they can no longer refrain from what to them is the irresistible conclusion, either that animals have souls of some kind, or else that men are like animals, only in some respects more perfect, and of consequence that they may die like animals, and human souls undergo dissipation and annihilation. Nor is it wonderful if some thinkers have fallen headlong into this conclusion, considering their ignorance of the nature of the soul.

The soul is immortal.

If, however, they had thought, that the end for which the world was created is divine, or is for the infinite in the first place; and that man is the ultimate effect, by which this end may be obtained; and that a soul is given him which in conjunction with the body has the prerogative of concluding, and by virtue of revelation, although not of itself as a finite creature, of believing that there is a God, and that He is infinite: and that in this way there is somewhat of the divinity in man: and if they had chosen to infer in consequence, that man is in this respect a partaker of the final cause; and that the soul, as a part of the purer world and nature, is, by the bond of the divine communication, comparatively near to the most perfect* of things; and thus can not only love the Infinite, but also desire a more perfect state: in short, if after forming certain conclusions, they had chosen to carry the argument into a higher sphere, they would clearly never have fallen into the error we have mentioned. Rather would they have seen, and their reason confirmed, that this ultimate effect, viz., man, who can acknowledge God, and through love feel himself in the bond of the final cause,—who, therefore, has in him God's final cause,—can never die, but is for ever a partaker of the final cause, and therein, of the infinite; in a word, a permanent existence: and nothing whatever could have induced them to believe, that this final cause would desert man at the hour of death; which indeed would be to accuse the infinite, whose cause it is, of finiteness or imperfection. And the same conclusion comes palpably before us with all the force of fact, from the circumstance that the divine end, which is only obtained by undoubting faith in God, brings with it such a bond between the infinite and the soul, that whoever undoubtingly believes in the existence of God, also undoubtingly believes in the immortality of the soul; while on the other hand, those who do not believe in the infinite, also do not believe in the immortality of the soul; but think finitely of both: which shews that the effect of faith is in this respect a sign of the connexion between the infinite and the soul, insomuch that no one can really believe the one without believing the other; or deny the one without soon denying the other. We may therefore conclude, that the immortality of the soul is equally certain with the existence of God; and that the divine end cannot fail to have immortality with it, seeing that true faith implies a belief in immortality.

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* We presume that by the term *the most perfect*, the author here means the natural minimum, the point, the seed of the world, of which he treats at considerable length both in this work and in the *Principia*. It is to be borne in mind, that there is a difference between *the most perfect*, or *the superlatively perfect*, and *the absolutely perfect*. The former is the highest of three degrees of comparison; the beginning of the series of finite perfections: the latter is infinite, and beyond comparison and series.—*(Tr.)*

We may also deduce and conclude analytically and rationally from the nexus of natural beings and things in the world, that the soul or subtlest part of the body must be immortal. For as the soul is in the purer and more perfect realm of nature, and the body in the less perfect, it follows that the soul cannot be obnoxious to change like the grosser bodily parts; and that it resembles the more immutable nature, as it has the power both to act and suffer, and to conform in every manner to the entities of that sphere, so as like them to enjoy the most complete immunity from change. But the immortality of the soul is declared by facts presented in our very bodies. For love, with its delicious sense, which is purer as the nature is purer, arises simply from the harmonious connexion of natural parts. It is afterwards derived *per nexum* into the grosser parts of the body, that is to say, into the less perfect sphere of the animal world, where it has again the same end, namely, of conferring perpetual life in a certain sense on the body also. But as this is against the nature of that mutable world of which the body is a part, so the body aims at perpetuity by the propagation of offspring, and the representation of itself in another being arising from it, in whom it may in a manner begin to live when itself surceases. This could never proceed from the body unless the cause and source preëxisted in the soul; nor could it be derived from the soul into the body save by connexion and contiguity, and consequently by supreme delight. As we may see from the consideration, that the soul concurs to obtain this end, a particle being veritably taken from it: so that in truth we know from the effect what is involved in the cause; from the last end what lies in the first; from the body what lies in the soul; namely, that in the body, by the instinct of the soul, a similar estate is desired to that which there is in the soul. And it is clear that the aspiration to this end is of a deeper and more sublime nature in man than in other living creatures, inasmuch as he not only enjoys the delights of propagating and rearing his offspring, but has also a perennial desire of living in the persons of his sons to remote posterity; whence it is seldom that parental love is extinguished, but encreases rather in descending to children's children. Not so, however, in the brute creation. For the same reason it is, that noble minds desire to be held in everlasting remembrance, and pant for fame and glory, for perpetual life in the annals of the race, their virtues aspiring to the integrity and perfection of a higher state, an antepast of which they already furnish; and to gain it, they are often impelled, sometimes in despite of the shrinking body, through death itself and contempt of all other pleasures; content if in this way the soul can give or impart to its beloved body what itself possesses. Still more is immortality evidenced by the fact, that those who are in the true bond of the divine end, or have a true acknowledgment and love of God, desire nothing more strongly than the immortal estate of the soul, and count nothing of less value than the mortal estate of the body; nowise fearing, but many times wishing, the death and end of the body; a condition of mind which can only proceed from the soul already perennially living in the bond of the divine end, and fearing lest aught should happen through the body to deprive it by any possibility of that high prerogative. Thus we *may* argue from effects to causes by the analytic method with good certainty; and by what we know, arrive at a knowledge of the unknown of which we are in search. Nothing happens in the grosser world but its principles lie in the subtler, together with the causes which determine it to occur in its own distinctive manner; nor is there a single end in the grosser world but respects an end in the subtler; although the latter end is only a mean to the essential end in the most pure being.

Furthermore, in demonstrating the immortality of the soul, we may infer from the infinite to the soul, as from the soul to the body; that is to say, from the connexion between the infinite and the soul, as from the connexion between the soul and the body: for as we said before, from connexion love immediately arises, or that delight which is felt in love, in other words, in the harmonious conjunction of parts and modes in the world. The love or friendship between the body and the soul, as between the soul and the infinite, lies entirely in the connexion. It is the sign and effect of love, for the first to consider the second as itself, for the one to regard the other as its own, or to see its likeness in the other; for unconsciously it feels in the other, by connexion of contiguity, the same as in itself. And since the love of self is the nearest and the strongest, hence what it feels delightful and pleasant in itself, it earnestly desires in its object as another self; and loves therefore to assign and to give to it what itself possesses as an essential good; or longs to find in what is connected with it the same or the like state as it has in itself: and so the soul wishes for the body, the same purity, perfection, and perpetuity which it possesses itself. Those then who are in the nexus or bond of the divine end,—which bond is perceived in the delights of the love of God,—cannot but be reciprocally in God's love, inasmuch as they are in the divine nexus; nor consequently can His love towards the soul be other than similar in this respect to the love of the soul towards its best beloved, because its most united, friend, the body; wherefore it must infinitely wish the soul to be his likeness; and love to assign and to give to the soul what itself possesses, that is to say, perpetuity and immortality. If the infinite did not respect as its own the finite which is connected with it, particularly in that essential particular, of ing the soul like itself in immortality, then there would element of infinity or absolute purity in God's love toward man, but, on the contrary, a something repugnant to the infinite. For did God admit aught of mutability in his likeness, or in the being connected with him, there would certainly be something in his love that he himself does not possess, or that is contrary to him; that is, which is not his likeness but his unlikeness: this, however, even in the natural sphere, can only exist towards objects which are unconnected or inimical. But this love can only extend to the parts of the purer world, *i.e.* to the soul; and not to the parts of the comparatively impure and imperfect world, or to the body; which cannot be otherwise in the divine nexus than through the soul, as both soul and body cannot be otherwise in the same than through the infinite nexus of the only-begotten Son. Nevertheless, if the body could be so completely governed by its purer essence, the soul, as readily to obey its every intimation and command, in this case the very body might be considered as a part of the purer world, and might enjoy the same immortality and integrity as the soul. It seems likely that this was the state of the first man, formed, as he was, in correlation to all the harmony of the world, and that in him all the grosser parts admitted of being ruled by the soul, and consequently with it could enjoy immortality. But when this integrity and perfection in the connexion between the soul and the body, and therefore in the connexion between God and the soul, had perished, and afterwards degeneration had naturally ensued in the posterity of Adam, then of consequence the body could no longer be considered as a part of the pure and perfect, but of the imperfect world: and so mutability and mortality invaded what was once immutable and immortal; prerogatives, however, which may possibly be regained if the soul be clothed with a body which is not immediately inherited in the hitherto natural manner from an imperfect parent.

In what sense the subtle world is more perfect than the gross, is plain from the analogy of all the parts and modes which enter into the compounds of the former sphere. For the subtler a part is, and the nearer to its simple, the less is it subject to modification; and in the same proportion, the more like and homogeneous is one part to another: and the more the *parts are* similar, the more perfect are they both in substance and mode; and hence all parts thus homogeneous aspire with comparative purity to subsistence and perpetuity in their figure and motion. And thus the entities of the subtler world, among which the soul is one part, become less obnoxious to mutability: and can be harmed neither by their likes, nor by any heterogeneous presences, for which indeed there is no room; nor yet by grosser matters, which cannot act immediately upon these subtle parts, or if haply they do, cannot disturb their connexion with their fellows which are so similar to themselves.

But probably there are some readers who will not allow this, but will persevere in their own unbelieving imaginations, and require to perceive the soul as they perceive the objects of sight and hearing, and to comprehend truth by sense, and will not be even then satisfied unless they can thrust their hands into the prints of the nails. My end, therefore, at present is, specially to demonstrate, to the best of my ability, the nature and properties of the soul, and then to shew from these endowments that it can never die without all nature be annihilated: and such being my end, I do not see how any one, unless indeed some singularly obtuse priestling, can disapprove of the undertaking.

§ IV.

Let us now enquire in a general manner into the nexus between the soul and the body, and into the operation of the one upon the other, with a view to see in what its mechanism consists. We say, *in a general manner*, for if all the details of the subject were to be set forth specially, we should rather be entering on the work of years than of a month, and we should not be writing one book, but a series of volumes. For to prove all our points, we should have to take account of all that anatomy has discovered in the body, and of all that we know specially, and by experience, of the understanding, the memory, the will and the affections. Besides which we should be bound to avail ourselves of both the mechanism and geometry of these as well as of all other parts by whose connexion effects are manifested. This would require more time and space than we can bestow in these preliminaries, at any rate so to draw them out, that their truth should be reasonably plain. We will here, therefore, present only a general idea, so as to enable the reader to judge in a general manner, antecedently to demonstration, at least whether what we say be agreeable to reason, or the contrary.

There is no connexion between finites without natural contiguity.

I. And the first general proposition we would state is, that all connexion supposes contiguity, and that no connexion can be conceived or given without contiguity. Wherever there is connexion, there must be ends, and wherever there are ends, there must be means also. Moreover there is no connexion unless the ends are connected by the means. This fact, we mean, that connexion is inconceivable without contiguity, is familiarly known in applied mechanics. In invisible nature, connected as it evidently is with visible nature, contiguity is always supposed, sufficient for one part to be in contact with, and move, another, from one end of the medium to the other. Connexion by matter, or by motion, rationally speaking is alone perceivable by the mind, as consisting of means or media orderly and successively connected with each other, and by which the ends are brought into mutual relation. The same is the case universally with all those things that are incapable of being considered in this material manner, but which, however, still depend on, and proceed from, material and substantial subjects. Wherever there is any connexion in them, a connexion between them by contiguity is at once supposed, and this at last, if we push the matter home, supposes connexion of, or with, substances. But leaving these details, let us simply attend to the fact, that connexion supposes contiguity in substantials and modes, and that without it, connexion, finitely speaking, is inconceivable. All our knowledge of things through experience points to the affirmation, which reason indeed makes as well as experience, that there is a connexion between the soul and the body, whereby the one can operate upon the other, and likewise that the one does actually operate upon the other. Granting which, it is impossible to deny, that there is a connexion between the soul and the body, and that there are means to form and cause it. For as there can be no connexion, either in substantials or modes, *without* contiguity; and as we see that numerous operations take their rise in the more considerable organs of the body, and in the parts subject to mechanical laws, in their motion, and in many ways; so we affirm that there must be *contiguum* or contiguity, and that there can be no such thing as an absolute division or break between the soul and the body, but that there is a contiguity: of what nature, however, is a point for special demonstration.

The nexus between the soul and the body has its limits or ends included in man.

II. The second point we have to notice is, that the nexus between the body and the soul must have ends. In finite nature there is nothing conceivable but has its own ends; in short, there is no infinite nexus. And as we see that the nexus or *contiguum* between the soul and the body terminates on the one hand in the soul, on the other, in the visible organization of the body; so of necessity this *contiguum* must have its ends, and these must lie within the body. Or to state the proposition more specially, when any effect within the *contiguum* proceeds from the soul and the body, we affirm that let its nature be what it may, it must needs have ends of its own, or a separate starting point in either term. And inasmuch as the effect exists, or may exist, in the body, the ends must of course be within the body or included in the body. For if both the first and last end were not in the body, and both in this way included therein, and attached to the corporeal space, then no effect whatever could be perceived as taking place in the body; and consequently there could be no operation of the soul upon the body, or of the body upon the soul. If in fact the effect went out from the soul beyond the limits of the body, then the operation of the body would pass at once by connexion and contiguity beyond the soul to some ulterior end; and the effect proceeding from either end could not become sensible in the corporeal space. And therefore whatever we feel in the body as an effect of the coöperation of the body and the soul, must be distinctly related to ends comprehended within the bodily space. All, however, that goes further, as there is a *contiguum* through universal nature, may undergo dissipation thereby, but will not be felt in the body. In short, whatever is there felt, supposes ends within the body; and the fact of the ends being in the body, or enclosed in the bodily space with all its contiguity, on the one hand in the external senses, on the other in the soul, is the single cause which makes man live. The connexion of ends sensible through motion within the space, creates his living essence; the life being in exact proportion to the quantity of ends that can be said to be enclosed in the space, or to terminate within it. If a large measure of ends can be said to be enclosed, then the life is also large; if a small measure, the life in that case will be small; supposing always that the means are entire and unbroken. Moreover the longer the series of the contiguity, the more distinct the life. More or less, too, contribute to the result in some degree. But of these subjects we shall speak in greater detail in a special demonstration. We may now take it for granted, that the ends in man consist on the one hand in the external senses or their organs; on the other, in the soul; and that therefore they are twofold. And whatever then comes to the soul, must stop there, as having arrived at an ultimate end enclosed in, or attached to, the body. And whatever does so stop, man is enabled to perceive within his living space; and thus the centre of all perceptions lies in the soul, and all things first stand related in their rational conditions to the soul as a centre.

No perceptible operation can take place between the soul and body, without some previous mutation.

III. The next point is this, that if aught which is sensible or perceptible is to pass from one end to the other, or between the two ends, it cannot do so but through some mutation. If no mutation existed in this animal *contiguum*, nothing sensible could be, nothing could be perceived. Were there no mutation, there would necessarily be quiescence of parts, and consequently nothing sensible, or distinct from rest, because nothing active. Suppose a *contiguum*, and also ends, and in the *contiguum*, or between the ends, suppose simply nexus in substances, but without mutation; and can you in reason perceive how anything could exist on such conditions? But the point may perhaps be more clearly illustrated by gross sensible objects. Thus there is no such thing as taste, unless something is present to cause a change or mutation, and to enable us to feel by taste. Were nothing present there would be no taste. And in smell unless there were something to move the organs, or induce a change, there would be no sense of odor. In the ear were there nothing to move, and no undulating motion, there would be no hearing. The same is the case in sight. If hearing and sight, or the organs thereof, were wanting, and mutations were unable to proceed from them onwards by contiguity toward the soul, there would be no sensual element at all. Therefore whatever is perceived from one end to the other, must have its cause in some mutation.

No mutation can happen without motion in the natural sphere.

Now it follows from these considerations, that in finite parts, in so far as they are extended or natural, no mutation can happen without motion: be the finite parts gross or subtle, so long as they are natural, they cannot be changed without being moved. The one condition supposes the other. So that when we are treating of extended or finite things, we may be sure that no mutation can exist otherwise than by motion, whether the motion be of the parts or the whole, so long as the mutation exists. In the animal *contiguum*, therefore, in as far as it is finite and extended, that is to say, natural, in so far motion is the cause of all mutation. Once more take the case of the external senses. How could one hear without motion in the air, and communication of the motion to the drum of the ear, and consequently to a graduated scale of finer and finer organs? How could one smell without there were something to move the olfactory organs, and in moving them, to originate motion? The case is the same in taste; and in sight also. For the formal element cannot exist, unless there be something to make or cause it; either motion in the parts, or motion extraneous to or beyond them. We do not wish to come yet to the inner sphere of the body, notwithstanding which we may argue unhesitatingly by the connexion subsisting between it and the outer. If at one end of the animal body, namely, in the external senses, all things exist by motion, and if there is a connexion between the body and the soul, and the other end lies in the soul; and if that which is felt through motion at the one end, is felt in the other also, it cannot pass through this *contiguum* to the other end otherwise than by the means existing in the first end, that is, than by motion. It would be unreasonable to attempt to say, that although the sensation exists in the first end by motion, it does not therefore follow that it exists in the other end by motion. For if motion begins in one end of a *contiguum*, it cannot be said to be dissipated before it comes to the other: were it so, there would be either rest in the soul, or no mutation: although it is impossible to deny that there is indeed an active, motive and efficient element in the soul. This, however, cannot possibly exist without mutation. Since at one end mutation consists in motion, why should we deny the fact of motion? Why should one say that the mutation at the other end consists in some mode different from motion? If you say that there is a mode which cannot be called motion, in short, a state, and that the mutation can only be called mutation of state, and not of motion, pray then what kind of state is it whose mutation may be called change of state, and not motion? If the state be infinite, I have nothing to rejoin, but most willingly admit that it is not motion; though by the way in this case it is not change of state. If the state be finite, there cannot fail to be a quality in it, for there is in every finite. But without motion can there be any mutation in finite or extended beings? The mutations however in modes proceeding from that finite, may by analogy be termed motions, as they come from their substances or subjects: and thus motion is predicated of substantials. But not to dwell longer on these particulars, we shall only observe, that if in our explanation of special principles we can demonstrate, that motion is the cause of sensations through the external sensory organs, and if motion passes through the *contiguum* towards the subtlest sphere on its way to the soul, and if all perception, understanding and memory, and the like, can be mechanically and geometrically explained, then perhaps the reader will not be so ready to deny, that motion is carried *per contiguum* towards the soul, and that there is motion in the soul, most distinct, however, and most subtle, and yet like that in the grosser parts.

There must be substances in man recipient of motion.

IV. If then connexion consists in contiguity, and the body operates upon the soul by motion, it follows again that there must be substances adapted for receiving the motion; substances, that is to say, extending from the body to the soul. If there be *contiguum* or contiguity, and if the operation take place contiguously by motion, evidently there can be no contiguous operation reaching to the soul, unless there be means through which it may exist. If there be motion, and the motion be carried by contiguity to the soul, there must be substances capable of receiving such motion and conveying it. If there be an end, there must be means: if a mode, there must be a substance from, or by, which, it exists. Mode is nothing without substance, motion is nothing without substance. There is no motion without there be something to be moved: motion, unless it supposes a subject, is a nonentity. If then there be motion, mutation, or mode passing from the external parts of the body to the soul, there must be a subject by which the motion, mutation, or mode exists, and consequently there must be substances adapted to receive the motion, and to convey it towards the other end. For a moving body is a mechanical thing, which necessarily supposes also a geometrical element set in motion, and supposes further a geometrical element in the motion itself, so far as regards the direction of the motion. It supposes again a geometrical element, or something else, to be moved, before the force can be heard or felt. That is to say, every moving body supposes a mode proceeding immediately from a substantial, and acting immediately on a substantial. And this mode, as respects time, is past in effort, but present in act, and future in its operation on anything else. However, the moment it acts, all are present. And thus the motion or the mechanical element is identical with the substantial and geometrical.

There are several elements connected with each other by contiguity.

V. The same may now logically be predicated of the elements of the world; to wit, that there is a connexion between them, also a contiguity, and the connexion indeed by means of the contiguity; whereby all things, whatever their description or number, are mutually respective or related, and connected from one end to the other, *i.e.* from subtle to gross, and *vice versâ*. I say, logically, or by the connexion of our argument, for we see and perceive that one corner of the world is connected to the other, and that the nexus reaches from the sun and stars to the eye of the beholder. From every earthy particle we see that there is a nexus, and therefore a contiguity, whereby the eye, at great distances, can join sight with the very particle seen. We see the same in the ear, there being a connexion between it and the mouth of the speaker. No effects of the kind could be either seen or heard were there not a connexion by contiguity reigning among the parts. Let us restrict our attention to the grosser element, namely, the air. Now we see in the air a connexion of parts amounting to such perfect contiguity, that no interruption whatever takes place to make the hearing fail. We find that the air may be compressed and dilated with such perfect uniformity, that when confined it presses equally in every direction, operating by the most constant natural laws. This supposes a contact between all the parts, and consequently a connexion by that contiguous contact. I do not believe that any one can bring a reason instructed by experience to deny the existence of elements in the subtler world. No one denies the existence of ether, for what an amount of phenomena are seen by the eye, and what changes are caused by the elements in the various organs! Hence, though sight cannot see the parts that cause or make sight, nor even the parts in the air that cause hearing; nor that affect the organs of smell or of taste; all these being internal to the sphere of the senses; yet we cannot, and ought not, on this account, to deny their existence; for we do feel their effects. And as in nature's subtler sphere we see phenomena so admirably wonderful, and which cannot be attributed to either the air or the ether, does not this argue the existence of elements still subtler than these; and that it is not unreasonable to affirm it, albeit the mere external senses cannot shew the fact; and likewise to presume a connexion reaching from the first minimum entity to the grossest in the elemental world, in short, to the aërial element itself; a connexion whereby one element moves, and is moved by, the other; whereby, from the very first simple, one has successively originated from the other; whereby, consequently, one subsists through the other. But we will not here confidently assume so much without demonstration; but will only remark, that the reader is bound in reason to grant us, that there is a connexion in the elemental world from least or subtlest to greatest or grossest, and indeed a connexion by contiguity—*per contiguum;* and that without nexus or connexion nature is inconceivable. And in short, if any one rightly applies reason to experience, and the soul to the senses, I see not how he can deny nexus to elemental nature, which is the most fluid nature of all, since nothing natural can be conceived without nexus; or deny that all the causes and all the principles of things and modes existing in the grosser world, lie in the subtler world. As for the nature of the elemental parts or constituents, it is a subject for which we refer the reader to our *Principia*, where we have treated of the elemental kingdom. We will here content ourselves with citing from that Work the following: viz., That if an element exist, it must needs be fluid enough to be capable of the aptest fluxion; nor can it be capable of this, unless each particle be fluid, and therefore contribute to the motion of the whole, to the general motion, to that of the volume. Did not each particle contribute, cohesion of parts would ensue, and no elementary fluidity could exist. And if each particle contributes to the motion of the volume, we may be sure that the volume during motion must move with reference to the mechanism and geometry of the parts. And if a large volume in motion be similar to a small one, we may conclude by induction that the moved volume must at last be similar to the particle it consists of. Proving that from effects, or the motion of the volume, we may judge not only of the peculiar geometry existing in the parts, but also of the particular mechanism existing in the elemental world: especially as the motion of the volume or the effect of the parts is always so extremely self-similar. And if the fluidity of the parts or the volume be elemental, and enables them to undergo motion as well particle-wise as volume-wise, it follows of course that there is elasticity in the parts; as indeed might be inferred from the circumstance of there being elasticity in the volume; which could not exist unless it existed correspondently in the parts. All this is perfectly evident in the air. And since we find that there is an element subtler than the air, viz., the ethereal element, and this, of the most fluid property, and immeasurably surpassing the air in the moments and degrees of its velocity and fluidity, hence I do not know what other account can be given of its fluidity, but that each particle contributes separately to the general motion; and is formed so to contribute; and to be elastic, and perfectly adapted in point of mechanism and geometry to the general motion; and that it is far more elastic than the aërial element, because the elasticity of the air cannot be self-derived, but must have a cause, which cause must come therefore from a ground in the subtler elements next to it: just as the air cannot be set in tremulous or vibratory motion by its own power, but requires the aid of the ether; for sound penetrates the glass of the exhausted receiver, through which the air cannot enter. Thus motion, and elasticity in motion, come from the presence of more subtle elements. Nor do I see why it may not be inferred, that there is a succession of elements subtler still, involving still greater fluidity, higher mechanic adaptations for its exhibition, and more perfect elasticity; and indeed elements, and an augmentation of predicates, till we come to the least and most universal, to the element the most perfect in all such endowments. And as we see so many admirable phenomena in the elemental world, both in the air and in the ether, why not go further? Why not boldly advance by reason to a subtler sphere, and arguing by analogy, infer its possibility and existence. And if we find experience confirming reason, and that causes are explained by it, it will then be right to conclude that we ought to go beyond the point where the bare senses begin and end; and at least to declare for certain that a connexion exists, and a contiguity also. For when the infinite had created his minimum entity, it appears that he willed, naturally speaking, to make it the cause of the creation next following, (as we always see in the finite sphere that one thing is the cause of another); and created no second compound immediately like the first, but chose that the first should be the means of producing the second, and the second, of composing the third; and this, both in successive and simultaneous order. If the origin itself took place by connexion, like the causes, then all things must subsist by the same causes as gave them origin. In a word, it is rational to affirm the connexion of the elements, and in fact, the existence of an elemental *contiguum;* for one element cannot subsist without connexion with another, and the end cannot *be* without the means: supposing it were the ultimate end, it must stand related to the first by connexion and contiguity. Otherwise the last end would perish, and the grosser world would fall into very ruin: nay, it could not be really separated from the subtler without annihilation. As this view of the case is to the last degree reasonable, I cannot see, if we grant the existence of a nexus and connexion, how we can do other than grant that there are subtler elements as well as grosser, and that the gross are connected with the subtle by contiguity. But we have treated copiously of these subjects in our *Principia*, where we have established four elements; the aërial element, the grossest of all; the ethereal element; next, one still subtler, to which we have given the name of the magnetic element: and next, another, the subtlest or most universal element of the world: the whole of the four standing in mutual relation to each other both as regards origin and subsistence.

Since then, according to all reason, there is a succession of elemental particles of different sizes, smaller and smaller, and which are capable of motion singly or separately, and consequently of fluxion, elementwise,—it follows demonstratively, that the particles of the gross element must move comparatively slowly; those of the subtler element with greater velocity; those of the subtler again with greater velocity still; and that the particles differ in their degrees and moments of velocity in proportion to their masses. This is equally a matter of sense as of demonstration. For we see that water moves slower than air, air slower than ether, and therefore ether slower than the next finer element; and so forth. Thus in proportion as parts are minute, and near to their first simple ground, they are also less in mass, their dissimilitudes are less, their disabilities and impediments are less, and their figures are perfect: in other words, they are in the same proportion perfect both in their geometry and their mechanism; they are quicker to move, and swifter in motion, being less impeded by bulk, dissimilitude, and a number of other modes and conditions which have the power of causing at all events a certain amount of resistance, stoppage and irregularity. In short, the nearer they are to their simple, the purer are they, and the more approaching to superlative perfection in all their mechanism and geometry. And it is also a consequence of these premises, that they are capable of moving distinctly exactly in the same proportion as swiftly and perfectly; there being not only very slight dissimilarity in the motion, but the particles undergo modification of the most distinct kind as contrasted with the modifications and motions in their grosser correspondents; and furthermore can make thousands upon thousands of moments in the most distinct manner, while the volume of the grosser element is making a single one, and that one, far from distinct: especially, too, since the elasticity in the lesser particles is more excellent, pure and perfect, amounting in them to the primitive and prime essence of the power.

And since there is a contiguity of all the elements, it follows that none of them can be set in motion without the motion being felt in some measure in the others also. Where there is a *contiguum*, nothing can exist in one part of it without becoming sensible to a certain extent at the other. What occurs at one end goes at once by contiguity to the other. When the air moves, the ether cannot but feel it, and the subtler elements too, even the last and first; there being a connexion of motions as well as a nexus of parts, a connexion of modes as well as a nexus of substances. If then the air be the grossest element, and the others are finer and finer in succession, and a motion have commenced in the air, it is a demonstrable fact, that the motion in the air, however small, becomes additionally sensible in the ether, and more so still in the finer elements. The least motion in the air cannot but exhibit a like motion in the ether, but as the parts of the ether are finer than those of the air, so a little volume of ether may be set in motion by a single particle of air: and by the same a larger volume, so far as number of parts is concerned, in the particles of the still subtler elements. If the motion of a particle of air is slow and confused, it will be successively more and more distinct in the ether, and in the primitive elements, with their parts so exquisitely minute. And thus when any motion commences in a gross medium and tends to a finer one, it becomes more and more palpable, and therefore distinct in its course. Tremulation in air will cause undulation in ether, and this, in its turn, a far greater undulation, indeed, a species of local motion, in the next subtler element. This may be shewn by a series of balls of different sizes, which, if elastic ones be chosen, will afford a sensible proof of our argument, and lead to the conclusion, that the like is true of the very least particles, that are, or that can be, beneath our senses. But perhaps we have already dwelt too long upon this subject.

The elements operate on the substances of the animal frame: and the like exists in the elements as in animals.

VI. We may now approach the mechanism that intervenes between the body and the soul. We have found that there are elements which operate upon the organs of the body, as for instance the air, which operates upon those of hearing, and the ether upon those of sight. And as they can only operate by mode or motion, (no operation, as we said before, can exist without mutation, and no mutation in the finite sphere without motion either of the whole or the parts,) so there are elements that operate on the organs of hearing and sight, and this, by a motion which, in the air, we know to be undulatory or tremulatory, the ether contributing to produce it; and the motion being an admitted fact at the present day. For the sound is plainly produced by the motion of the nerves or membranes; the tympanum is visibly extended in the ear, visibly adapted also for receiving the motion; besides which there are finer organs present to carry the motion inwards, and subtilize it into sensation. We may therefore infer that the same scale of progress takes place in the ether, whose modification consists in motion, inasmuch as it moves the organs of sight to exercise sensation. For undulation as existing in the elements, or in their parts, or parts of parts, (on the position and motion of which their formal essence depends,) is in fact their most general, as well as their most natural, motion, because by it they move particle-wise or particularly. And as in the undulations of an element there may exist all the conditions on which the infinite variety of phenomena is explicable; and not only explicable, but geometrically and experimentally demonstrable; such conditions, we mean, as this, that an element admits of innumerable undulations simultaneously and successively; that a lesser and larger, a quicker and slower undulation, may exist in one and the same volume; and the lesser within, and together with, the larger; that there is nothing to prevent new undulations from constantly entering an identical tremulous volume, and coexisting therein, thousandfold variety thus taking place in a single *contiguum*. This is cognizable in air sensually, in water visually, and we know it demonstratively by the mechanism of the parts. If then corresponding undulatory motions exist in the minutest elements, in which all modulations are far more distinct, sensible and perfect, of course they may still more distinctly admit the existence of an added number of tremors. These particulars, however, will require a special process of deduction.

VII. Seeing then that the elements consist of parts that are to the last degree moveable in the cosmic space, and that in this respect they are the very sources of motion; and that they are moveable in any given space or place, whether they be in a state of compression or dilatation; a quality by which they can enjoy both rest and motion, passion and action, and the possession of which in fact constitutes them so to speak the life of the universe,—seeing all this, we cannot but conclude, that all motion in man from one end to the other, from the external senses to the very soul, through the whole human *contiguum*, is in this respect like the elements, and indeed is the microcosm of the universe; and that in man, too, all actions take place by means of *contiguum;* the motion tending from gross to subtle, from the senses to the soul; and in ascending the scale of finer and finer entities, stopping in the finest of all as the centre; that in this upward course, it becomes more and more sensible, more and more distinct, as we said of the corresponding motion in the elements; that it becomes more and more nicely fitted to receive all kinds of varieties; and the finer or subtler the other end, the more sensible and distinct the effect of the motions; so that at length there is nothing in variety but may be distinguished, and nothing but may be distinguished by variety: not to mention several other particulars in which human life seems to follow the pattern of the elements, and to take similitude therefrom. On this ground it is, that the theory of the elements requires to be delivered before we can labor with the least effect towards a knowledge of the operations in human life.

VIII. But living creatures, of which man is the last and most perfect, do not consist of elements, but are bodily or corporeal, and therefore we have now to consider the structure of their bodies. As we see that such wonderful varieties of motion, both simultaneous and successive, are possible in the elements; and that these varieties become increasingly multiple, sensible and distinct in the subtler sphere; and that in this respect the animal body is like the elements; and as that body is corporeal, and not purely elemental,—so let us observe whether aught having similar relations, or recipient of the above varieties of motion, is to be found in the corporeal sphere. And first let us regard those large and more considerable parts whose bodily mechanism is evident and admitted. Now the motion of the air is received within the body by particular membranes. We see this in the whole construction of the ear; we see that the entrance or external meatus is closed by a membrane, upon which the undulating air will necessarily impinge, and cause in it a corresponding undulation. And on examining further into the internal conformation of the ear, we again find membranous expansions of a finer and finer texture; and also machinery for concentrating the undulation, before it is conveyed to the higher sphere; so that the resulting sound may become more articulate. And the same process takes place again and again as the undulation passes inwards. In the eye we have a machine, all whose parts conspire to enable the rays of light, or the modulations of ether, proceeding from the whole space that is comprized at once in the field of vision, to make their way distinctly towards the retina; so as afterwards to be spread through the optic nerve, and at last diffused through, and immersed in, the substance of the medulla oblongata, and of the cerebrum. All these facts are visible and tangible; and it only remains for us to bring reason to bear, and before coming to a conclusion, to enquire, whether the above parts, with no exception, are not bodily formed and fashioned with a view to the undulation or modulation begun in the element, being carried inwards bodily, that is to say, through bodily parts? In answer to which enquiry, we are bound to conclude in reason, that there is no alternative, but that the above motions must be received, and carried inwards, and ultimately to the cerebrum, by bodily organs. And as we find that a peculiar sensation exists within

There are membranes in the human body to receive all the motions of the elements.

of which the subject is conscious,—and that there is an imaginative faculty, which is active enough for the man to feel it, and for his very body so to feel it, that in numberless instances the grosser parts of the frame, the blood, and the other fluids, together with any saline, sulphurous, or other particles that they contain, are excited and moved thereby,—so we are bound in reason to conclude from fact, that here the cause can be of no quiescent or passive, but of an active character, and in short that it can be no other than motion.

Let us, however, pursue the argument, and observe if there be anything in the body that on mechanical principles will receive the motions in their various degrees of subtlety. Thus much is certain, that in the grosser parts there are drums and membranes admirably conformable to the motions of the aërial element. We have now to shew by induction whether there are membranes of different degrees of subtlety, and which are conformable to corresponding motions in the subtler elements. Nor by rational analysis can we conclude otherwise than in the affirmative. For if there are membranes to receive the undulatory motion of the air, then why not subtler membranes to receive subtler undulations? It is at all events possible that there are, and being possible, is it also fact? To determine this we must have recourse to anatomy, and examine the several parts of the body, availing ourselves also of the assistance of the microscope, and we shall find that a very large proportion not only of the brain but of other parts of the system, consists of membranes. In the cerebrum, for instance, we shall see that there are membranes of different degrees of fineness, and that the finer membranes give place to others finer still, until at last the subtlety is so extreme that neither the eye nor the best microscope is adequate to recognize it. The difference of the membranes in fineness is plain enough to the naked eye. In general moreover we find that there is hardly a part in the human body but runs through a scale of fineness or subtlety, ramifying, and in this way diminishing, until it eludes the power of the senses. This is clearly evident in the veins and arteries, in the nerves, in innumerable other parts, and among the rest, in the membranes. We may very fairly conclude from it, not *only* to the possibility of the subtilization of the membranes through finer and finer expansions, one after another, but also, on the ground of anatomical demonstration, to the actual existence of the same. Besides which we have the same ground for asserting, that there is no part of the human body but is clothed by one or more membranes of different kinds. The individual man with all his members is enclosed in membranes, two or three; the cranium, the same; the cerebrum is clothed with its own membranes, gross and fine; so also the cerebellum and the bulk of its parts. The like is true of all things in the lower sphere of the body, as well as in its parts; nay, of even the minutest vessels. The bones, wherever situated, are clad with peculiar membranes. The nerves too. The fat, particle by particle, is enclosed in an infinity of membranous loculi or cells. And thus in the body, whether we consider it as a whole, or regard it as made up of parts, and parts of parts, the anatomical eye recognizes that all things are enclosed in membranes, and that the membranes ramify, and become finer and finer, until at last the eye can see them no longer. Yet to argue that because they cannot be seen, therefore they cannot exist, is to draw anything but a logical consequence. It is more reasonable, as we see the membranous form wherever the eye can reach, that reason should begin where the eye ceases, and conclude without doubt that there still are similar subtler forms, inasmuch as we see answerable effects in the subtler sphere.

IX. Having now arrived by the aid of reason at the conclusion, that the existence of the finer membranes is not only possible, but plausible, we have next to consider their qualities. And if they are formed for the reception of motions, finer and finer, on the pattern of the motions in the elements, it follows that the membranes must of necessity be tense. Motion cannot be received without tension. No tone comes forth unless the membranes exhibit contiguity sufficient to cause one part to move when the other does. Unless the drum of the ear be tight or tense, the air has no chance of producing in it motions answering to the aërial movements. Unless the nerve be tense, it will never allow any vibration to reach the sensible sphere. Tension therefore is required; and being absolutely necessary, the presence of a specific cause is also required to produce it. Here again let us first proceed to the experience the external senses, and when this fails, and not till then, let us appeal to reason. Now we see that the larger membranes are put in tension by various bodies that they enclose, either by bones, or by nerves, the coverings being stretched just as the parts enclosed stretch them. But to come to the membranes themselves, we see that they are stretched by liquids; evidently indeed by the blood and the different other humors. We also know by sight and experience, that the blood when collected in any quantity, is sufficient not only to stretch the parts covering it, but furthermore that the finer parts being attached and connected to the grosser, the tension arising from either the quantity or insurgency of the blood, is sufficient, taking into account the contiguity and connexion, to put the lesser membranes also in tension. We cannot stretch a fresh piece of membrane between the fingers without its finer parts undergoing a corresponding tension. If the tension is produced by swelling, either from the blood or any other fluid, it amounts to precisely the same thing, only it must be admitted that such swelling is a cause of tension not only in the larger but also in the finer parts. Experience is itself too eloquent on these subjects to require much assistance at present from reason. Thus we see that various membranes in the body are put on the stretch by the swelling blood. And as the result of tension we see not only an alteration in the senses, but even in the imaginative faculty, and in the muscles, as during anger, intoxication, accessions of fever, &c. The position is therefore experimentally clear, because we see effects which extend to the very soul.

Although, however, we cannot at present penetrate further by experience and the external senses, still it does not follow but reason may go further, and, assisted by geometry and mechanics, be as positive in its statements and conclusions as the external senses themselves; more especially if we reason from effects as well as in causes. As then the larger membranes are put in tension by the grosser liquids; by the blood and the rest of the humors; and as finer membranes do exist, and must equally have their peculiar tension, and if stretched by a general expansion, their parts also must be so disposed, as to undergo a perfectly even or equal tension; consequently as there must be some liquid or fluid to cause this power of equal tension, and to make the parts so preserve their tension as equally to diffuse over them the motions received:—so from the large and the visible we may conclude without hesitation to the minute and invisible, and infer that there is a fluid that specially stretches the lesser parts. And as there are membranes of superlative fineness, we may conclude that there is also a fluid of equal fineness, to enable like to operate upon like. And thus the inference that exquisitely subtle membranes are put in tension by an exquisitely subtle fluid, is repugnant neither to the experience of the external senses, nor to mechanics, nor to effects, but on all these grounds is perfectly agreeable to reason. And since from effects we recognize innumerable predicaments like and corresponding with the motion of the elements, it becomes probable from this also, that there is an elemental fluid of some kind to put the finest membranes on the stretch: and that it is finely elemental in proportion as the membranes are fine: the subtlety in the elements having its analogy in the membranes of the animal body; whereby the elements operate on their own correlatives in the body; and by a peculiar membranous connectedness and contiguity ascending from gross to subtle, the elemental *contiguum* conspires with the bodily *contiguum;* which produces analogous effects in the body and in the elements, with only this difference, that the *contiguum* in the body is enclosed in space, and undergoes tension and fluxion from one end to the other; whereas in the elements, there is no end or enclosed space, for the whole universe is their space and field. And consequently the membranes are designed to enable the motions to be confined to space and enclosed within boundaries. In short, a motion similar to the elemental exists not only in the elements, but also in the membranes of the body, which latter have their peculiar boundaries.

The membranes are formed geometrically, with exquisite precision, for the reception of the motions existing in the elements.

X. And for the above reasons the membranes also feel. For the soul operates upon the body through them alone, all the motions of the body are performed by them, and all vitality, and all the animal and sensual powers, consist entirely of their motion; so that there is hardly a single anatomist who does not declare without reservation that all the membranes feel. Whenever a membrane is touched, sense is at once excited, which shews that the membranes are means for sensation, although it is not felt at the point of contact until the membranes in the brain become conscious of it, by means of the contiguity subsisting in the latter, assisted by the elemental fluid. And in order, I repeat, that the membranes may the better adapt themselves to the sway, motion or vibration of the elements, in short, fall into imitation of the elemental motions, they require a formation so nicely mechanical and geometrical, as will capacitate them for receiving the whole possible mobility that exists in the elements; the motion of the latter being in this way fixed or represented in them. To fulfil these conditions, the middle membranes require to have in them not merely the due and fitting form and shape, but also the due size, thickness, and the several other qualifications which geometry can bestow. This, however, is not the place to descend to particulars. But unless the drum of the ear were exactly calculated to the vibratory motion of the air, both in thickness, figure and position, it could never receive as distinctly as it does all the moments and degrees of the aërial motion; and unless the same were the case with the inner membranes beside the labyrinth and cochlea, it would be utterly impossible for all the moments and degrees to penetrate so distinctly and with such concentration towards the subtler sphere.

Moreover unless in the middle membranes there were a peculiar system of attachment, sufficient to preserve them in their proper shape, and to produce the fittest and nicest division in each particular expansion; and unless they were so formed as to enable the elemental fluid to pass in the freest manner through them all as well as through their attachments; unless these conditions also were fulfilled, the membranes could never be kept perfectly equal in their tension, nor conform to any given motion. And therefore there ought to be the exactest harmony between the membranes and their corresponding elements, since it is by means of the latter that a perfectly similar motion may be diffused through the whole body, and consequently that membranes, always and everywhere similar, may fall into the same or a similar motion. The element is the only thing that can transfer motions. The membranes of themselves cannot be other than merely passive; yet are they so formed as to receive the motion of the elemental parts, and by whatever cause they are moved, they fall into imitation movements, and moreover act upon the enclosed volume of the element reciprocally. By the operation of the element therefore a similar modulation is diffused in a moment all over the body; and in this way the vibratory or undulating motions in the elements enclosed in the frame, are in the truest sense those animal spirits that are said to obey the volitions of the soul, and that realize whatever is desired by the body and the soul conjointly. But we shall treat better of this subject in a special theory; here we can give but a confused and general idea of the operation.

XI. As we learn by experiment that the vibrations or undulations of fluids follow their own laws of motion with the utmost exactness, and in fact that any element in motion cannot but move according to principles of its own, and according to the figure and mechanism of its parts; so again, as the elements fix their tremulous and undulatory motions in the membranes, they retain their own laws, and these, the most perfectly harmonic, in the purest form, and in the most exact manner in the latter, and the membranes cannot stir a single step without those laws. From the nerves equally with the membranes we learn the nature of these laws, and are taught that they are the laws of harmonic proportion, which is always in relation to distance from a centre. Let us take an instance from a membrane convoluted or formed into a spiral or any other figure conceived to have a centre. Now this membrane, at a certain or given distance from the centre, will necessarily move with a vibration proportioned to that distance or to those bounds, and the vibration will have proportional moments or degrees, and a proportional velocity: at another distance from the centre, either greater or less, it will necessarily take on a particular vibration proper to the place, and will admit of no other. And to make any kind of harmony between two or three distances, the distance of one from the centre must be a proportional of the distance of the other from the centre; and t distances must also be mutually related, and therefore t selves make harmony. And this is the case in the

The laws of motion in the elements, and the similar laws in human organs.

in which indeed there is the same ground of harmony; although the nerve can only respond to one tone, but the membranes to all tones. Where the nerves are many in number they may collectively represent a single membrane, and their proportions or harmonies will be as the distances already mentioned, provided the different nerves are exactly equal in tension and the same in point of thickness. And thus the vibration of membranes is always in the ratio of the distances from the centres, and if these are as the mutual distances, then the vibration is thoroughly harmonic. But all this applies to membranes which are geometrically constituted with a centre; in other cases the harmonic ratios are most nearly represented among the asymptotes in a hyperbola. The vibrations in the membranes before alluded to for the most part generate a geometry of their own, or acquire a particular harmony by habit and exercise; yet even this harmony always consists in the circumstance, that the distances from the centre stand in mutual relations to each other. The whole field of continuous harmony gives birth to a single harmonic vibration, which may be called a mixed or compound vibration. And a vibration of this kind may be still more finely concentrated into a unity in the subtler membranes. Moreover from a number of mixed vibrations, other mixed and compound vibrations may arise, and so on through successive degrees of elevation, as the membranes in the body are finer and finer, and fitter for a perfectly distinct reception of all vibratory movements. On the other hand, those vibrations of which the mixed order is composed, may be gradually, harmonically and separately brought out from the compounds, which in this manner may be resolved into their parts, if the mind attentively dwells upon them. Two tones or sounds may generate a third, which, however, will be precisely such as can fit in harmonically among the ratios of the distances. Like vibrations may produce their like in the adjacent parts; in the subtler parts; in the grosser; and this both simultaneously and successively: for a like vibration may in a manner spontaneously (by the mediation, however, of the element) cause a like vibration in another membrane, and consequently call forth other like vibrations which have been imprinted by use and habit: just as a vibrating string sets another string, whether thick or thin, of similar tone, into the same vibration with itself. And if in mixed vibrations there be several tones, a similar tone may be called forth from them in particular in another place; a tone either simple or less mixed. And if all the delicate membranes be harmonically enough adapted by use and cultivation, a genuine and perfectly distinct effect will be produced: all which circumstances must ensue, provided only there be a succession of membranes, finer and finer, and their position and shape fit them for the distinct recipiency of all vibrations, and for the production and representation of all. But the whole of these particulars will have to be deduced at large, and demonstrated geometrically, in a special theory: here we have simply been anxious to give a general idea of them, and by this means to help on others more penetrating than ourselves to a deeper investigation of the operations of the elements upon the membranes, and of the membranes upon the elements. In a word we would say, that so far as concerns the tremulous motion of parts or surfaces of parts, there can be nothing in the elements but is likewise possible in the membranes of the body, provided they are adapted to receive from the elements a motion imitative of their own. And hence numberless and almost ineffable varieties are possible, where there is a graduated scale of membranes, gross and fine, thick and thin, more or less, and diversely, tense, stout, figured, &c.: as many varieties in short as exist in the elements themselves. And thus the elemental world has made itself sensible by the membranes in the small world of the living microcosm.

This too it is which has caused many previous enquirers, (for I am by no means the first in this walk, but have had learned predecessors, with whom I will not venture to compare myself,) seeing the correspondence that subsists between the motions in the elements, and the motions in the membranes, to declare that vibratory or tremulous motion is the cause of sensation. Former writers, however, have not attempted to go beyond this general induction, but have betaken themselves to certain animal spirits of unknown operation, finding in them a general asylum, to make an end and mode somewhere to their investigation.

Granting then that the microcosm, man, within his boundaries, is analogous to the macrocosm within its boundaries; and that in the little human world there is a membranous as well as an elemental nexus reaching without a break to the very soul; and that the soul is a part of the purer world; or that one end of man is in the subtler world, the other in the grosser: granting these premises, it follows: 1. That all motion or mode in this animal and living microcosm comes either from the subtler world, and tends through the *contiguum* to the grosser, that is to say, from the soul to the body; or that the inverse movement takes place, viz., from the body to the soul. 2. If the origin of a given motion be in the soul, then it passes into the grosser world by connexion of contiguity, and this, harmonically: and where the harmony is true and perfect, the passage to the other end will be effected freely and instantaneously; and will be felt at the other end as well as in the means. Nevertheless in tending from the subtler to the grosser sphere, the mode or motion will become gradually grosser, more impure, less perfect, comparatively indistinct and rude. And if the origin of the motion be not adequate to the substances of the grosser world, piecemeal and gradually it may vanish away and perish, before it can arrive at the ultimate end. And if in the gross and imperfect world, or in the field of means, there be aught that is still less perfect, and greatly discordant, dissonant, or dissimilar, or if the *contiguum* be not sufficiently harmonic, in this case, as it proceeds, it will be confused, dispersed, perish and die away, before the mode has fairly reached its destination. 3. Suppose, however, that the source of the motion or mode lies in the first instance in the grosser world, and that the *contiguum* is harmonic, in this case it will pass in a moment to the soul, and be felt with pleasure in the middle terms, because it is felt with pleasure in the soul; and it will also be comparatively pure, perfect and distinct in the means, because it is pure, perfect and distinct in the soul; that is to say, it becomes relatively pure in proportion as it penetrates deeply into the purer world. But where the connexion of contiguity, or the natural harmony, is comparatively imperfect and dissimilar, it can reach the soul neither distinctly, nor purely, nor harmonically, nor delightfully; for it meets with a barrier of dissonance or discord on the way, and the mode is either dissipated, or comes confusedly, and with pain, to the soul. 4. Continually discordant modes, and their frequent use and employment, may produce a peculiar habitude, whereby at last the soul will seem to love discord in motions more than harmony, and to seek delight in dissonance and contrariety; so that it will begin to be formed upon the model, or to the modes, of the body, and to be assimilated to the grosser and impurer world: in which case its harmonies are discords. When such like souls are released from their bodies, natural harmony can give them no other than a feeling of dissonance, perpetual contrariety, and painful misery, especially when aught from the purer and more perfect world approaches them. For they enjoy no connexion, but are in perpetual discord, with the more perfect world; and can have no pleasure except in experiencing the dissonant modes of the impurest sphere which answer to their own impurity.

The soul is the centre of such motions.

XII. We have hitherto confined ourselves to the organs or membranes upon or through which sensations are conveyed by vibrations towards the soul; whereby the soul perceives all things with the greatest distinctness, and has concentrated in itself, than which there is no subtler essence in the body, all vibrations, both mixed and simple. Did not the soul consist of the very subtlest parts, so as of right to have conveyed to it all motions and vibrations by the midway of the membranes, it could never become conscious of any motion that begins in the first instance in the grosser organs. The membranes, therefore, upon which vibrations pass after the manner of the elements, are but organs between the external senses of the body, and the soul. Without these means, the soul would be destitute of all power and faculty to act or operate, and incapable of feeling what goes on in the grosser sphere; destitute also of the faculty to coöperate with the body, and of the power of calling into motion similar parts, and this, more and more distinctly. In a word, the soul would be without the body, and the body would be without the feeling of a soul. And if these middle
branes should lose either their connexions, or tone,
instantly a dissimilarity—a rupture of analogical
trary to usual habitude, must be represented to
when in this case the soul begins to operate, it

through a crowd of unlikely parts and circumstances, and no proportional or rational result will follow. Rationality is never therefore the product of the soul alone, but of the other parts as well which form the medium or *contiguum* that connects the senses with the soul.

In the soul undoubtedly we have the centre of all the vibrations we have spoken of, as well as a most active and supremely geometrical and mechanical essence, in which all motions and vibrations whatever are represented and felt, both distinctly and mixedly: and from which the whole of the finest vibrations are diffused over the multitude of similars, or excite motion among them: whereby lastly, through the analysis and harmony of similars and dissimilars in some third or fourth degree, or in any which is required, the soul is enabled to acquiesce or rest harmonically and delightedly.

XIII. But lastly, it is probable that the reader may be anxious to pause for awhile at this stage, and to ask us what we think about the place and residence of the soul in the body; what the soul's nature is both in point of mechanism and figure; also the peculiarity of its immediate or proximate operation upon the membranes which aid and subserve it: with a number of other questions concerning that part of man, which although the most unknown, is yet the chief of all, and which questions are well worth solving. On these subjects we will now open our mind, although in a slight and exceedingly general manner.

The seat of the soul in the body.

With regard to the place or locality of the soul in the body, it is clear from the foregoing pages, and from the reason of the case, that the soul dwells in no particular gland, in no particular membrane, and that it is not diffused all over the body: but that its dwelling-place is there, where the membranes pass through higher and higher attenuations, and attain the finest subtlety they can. When we examine the human cerebrum, we find that there is hardly a part of it but is enveloped and clad not with one but with several membranes: we find that the general portions of it are loosely invested with the dura mater; that a still larger number of its parts or divisions is covered with the pia mater, which dips deeply into the folds, furrows and crannies of the cerebrum; and that these two membranes accompany the spinal marrow where it issues from the head, and sheathe the nerves throughout all their wide courses and ramifications. Neither in the nerves, however, nor in the fibres, can we see that their ramifications form the smallest membranes, but for the most part they are evident and visible, although even there so subtle as to begin to escape our sight. Not so, however, in the cerebrum, all whose parts are enveloped with their peculiar tunics, and the tunics and membranes that are visible, and the still larger number that are invisible, can and do ramify in an eminent manner; from which it is fair to conclude, that the seat of the rational soul is in an especial sense in the brain, and does not extend beyond it. In the cerebrum we have the pia mater, a very fine and visible membrane covered with innumerable blood-vessels, and which ramifies again and again, and detaches tendons of the finest make, as well as an exquisitely delicate contiguity of membrane; all which dip into and pervade the cerebrum, and ultimately pass in a still more highly attenuate and subtle form into its very substance, first into the cortical substance, next into the medullary, in which latter, therefore, we see the most manifest signs of the ramification of membranes. And inasmuch as similar substances are found in nearly every part of the cerebrum, and also of the cerebellum, and in the medulla oblongata throughout, so we conclude that the soul resides particularly in the cortical substance of the cerebrum, and partly also in the medullary, where these exquisitely subtle membranes, from the structure of the organ, can run connectedly from particle to particle, and likewise above, around, and within every particle of the above substance. The cortical or cineritious substance lies immediately and closely under the membranes, being about two lines in thickness in the cerebrum, and making serpentine windings, and often penetrating inwards. In the cerebellum it exists in even greater proportion, and represents a beautiful tree or shrub full of branches, the trunks or peduncles of which consist of the three medullary processes. Furthermore, the pineal gland is of the same substance, and its processes and base are frequently medullary. The medulla oblongata, which lies under the two brains, and partakes of both, has some little cineritious substance inside it, but for the rest is medullary: the commencement of the medulla oblongata is of the same substance externally, while on the inside it is beautifully striated. I do not, however, maintain that the medullary substance is devoid of the soul, especially since in some places, as for instance the medulla oblongata, which is the fountain-head and origin of the nerves, it appears to be of a fibrous and tubular character, and mixed with the finest arteries of the cortical substance. But of all these subjects we shall speak more at length in special treatises. Here we only wish to shew logically, that the soul is in all those places where the membranes of the cerebrum expand into successive fields of diminution, and have a comparative fixity from the membranes which produce them.

The soul is the same wherever it is seated.

Granting then that the soul is diffused throughout the cortical substance, it follows, that it resides in no one place or spot, but is ubiquitous in all parts of the brain, in none of which is it self-dissimilar, but always most self-similar, and cannot operate differently in one part from what it does in another. For step by step, degree after degree, it is fitted for motion, and if we may be allowed so to express it, is formed according to the motion of the middle membranes; and as these pass in all directions around the cerebrum without a break in their continuity, so the soul cannot be presented differently in the medulla oblongata from what it is in the cerebrum, nor in the cerebrum from what it is in the cerebellum; and this, by reason of the contiguity and connexion which there is both in the membranes, and in the motions through the membranes.

But perhaps a question suggests itself, whether we are to consider that the soul is alike in all brains or in all men? To which we reply that it is not alike, but of different formation in different brains. However, it is not our present business to explain what the difference amounts to; although it is clear from the course of the argument, that the soul is not only wrought, developed or cultivated, but is also adapted by use and exercise through the intermediate membranes, and rendered more or less fit or unfit for receiving the motions that reach it thereby: and that in some persons its connexion with these membranes is comparatively slight; in others, intimate and *close;* in some it is accustomed and adapted to call distinctly forth the similar motions imprinted by use and culti others, to call forth but a small number of simi vast number of dissimilar motions: in some it is mor in others less so: in some it conspires in one aim with the body and the pleasures of the body; in others it involves a resistance to the body, and rather longs for, and aspires to, the rational estate. In short, there is generally, although not always, a certain agreement and similitude between it and the body. This is displayed in families, where the youngest branches are frequently more like their grandfathers and great-grandfathers in disposition, than like their own parents, from whom they immediately got their souls; or from their great-grandfathers through their parents. This is the reason why grandfathers commonly love their grandchildren more than parents their children.

Again, are we to consider that the soul consists of nothing but a membrane, and therefore is perfectly similar to the intermediate membranes? We answer that by the foregoing arguments its conditions cannot possibly be like those of the above membranes. For the soul is the last and subtlest part of the body. It is the part which is the ultimate end where all the intermediate motions terminate. It is the part to receive all modes in the most distinct manner, and out of mixed and still more compound vibrations to form a simple and distinct essence. It is the part where there is a centre to which all the subtlest vibrations can refer themselves: in which there is nothing of elemental existence, but an essence the most active: without which none of the momentaneous intuition, distinctness, or vitality of the rational power, could possibly exist. If the reader will please to consider this superlative activity of the soul as not unlike our actives in the *Principia*, Part I., Chaps. V. and VII.; he will find, that actives regarded separately from their membrane or envelope cannot be conceived as occupying place or determinate situation; or as forming a contiguity or expanse; of which therefore in themselves they are devoid; nor do they at all imply the relations of upward and downward, or of resistance, but only pure agency; nothing, however, elemental, nor passive, though notwithstanding they involve pure mechanics. But see the *Principia*. All these predications agree exactly with the description of the soul given by those who love to claim it as spiritual and not material.

This perhaps is that purely actual and simple essence that is commonly attributed to spirits and souls, and which in some sense may exist without involving the conception of extension or any merely mechanical notions. We have stated, however, that the finite actual is impossible without a mode, not only of being actual, and of being able to become so, but also of being of the quality it is, and of the mode or modification that it is, both in itself, and when it operates upon confessedly material objects. For no finite can operate on finite matters without a mode; or without a mutation coming from an actual substance; nor can there be any mutation in passives without the local motion of an active: although still this is merely mechanical.

How the actuality of the soul is to be considered.

But as regards the operation of the infinite on corporeal or bodily substances, and particularly its immediate operation upon the primitive, and the successive and mechanical operation of the primitive upon the substances derived from it,—this is not analogous to the actuality here mentioned; for the one is finite, the other infinite, and we have no right to explain the one by the other in the way of simile or analogy, or to liken God to spirits in point of actuality. This I believe is forbidden to all, and especially to Christian philosophers, who are bound to admit nothing in God but infinity, nothing in other spirits but finiteness; there being therefore no possible ratio or relation between the two. The difference between the infinite and the finite is so great, that the difference between heaven and earth is nothing to it. Actuality in the infinite must be considered as without mode, unless mode in an infinite sense: but the actuality in spirits, as involving mode; for in finite spirits nothing can be set in activity without a mode: and mode in finites there is none but what is immediately referable to substances, and proceeds from them.

Actives cannot be finited without passives or a surface.

But as actives of this nature cannot act, or put forth any motive force, or produce any effect, upon bodies near them, or which they encounter, unless such actives are enclosed in particular surfaces or membranes that will simply obey or comply with the motive force of the actives; so the soul cannot be said to consist barely of the above actives. It is true that its activity and life consist of them: but it is also requisite that the adjacent parts shall be enabled to act upon the soul, and in a manner to dispose it for action: there must consequently be a passive ground in the soul. Moreover the force of actives upon bodies near them cannot be conceived without a space, in which these actives, thus perpetually operant, are enclosed. And as space cannot be enclosed by them without a membrane of superlative subtlety; so we conclude, that the activity, together with its own peculiar surface, jointly constitute the soul, without which no operation upon the body is possible. And to obtain this result, the membranous surface must in all reason have a centre, by virtue of which, and therefore of the distances from the centre arising from this relation of things, all that is superlatively distinct must have its existence; and without which no distinctness could be.

The souls of brutes. In brutes, however, or in all living creatures but man, the soul is formed on the model or in the likeness of the human soul: but it is much more gross, it is elemental, not consisting of actives, which constitute the actuality of reason, but of a peculiar elemental ground. These are points which we design to prove in a special treatise by a host of arguments which are not perhaps very familiarly known to the learned world.

We have no reason to despair of arriving at a knowledge of the soul, especially if it be no longer regarded as an object of supreme ignorance, and as operating by absolutely unknown laws. For if there be simply a geometrical ground, of the most perfect kind, however, in the soul; if there be simply a mechanical ground, and this also equally perfect, we may then have hope of at last arriving at a knowledge of it: but never, if principles utterly unknown, and which simply aim at ignorance, are assumed at the outset. But we may attain to knowledge on the subject, provided we assume that the actuality of the soul consists in a motion and power consummately mechanical; its surface in a figure supremely geometrical: in a word, if we take for granted a something most perfectly mechanical and geometrical in the nature of things; and if the mind, cautiously and dubitatively during the enquiry, brings before it a geometrical expanse of the kind, and afterwards examines all the facts with which experience supplies it; that is to say, the anatomy of the human body, of all its parts, and their parts, and of all the organs existing both in the brain and in the body throughout; of all the organs of the external senses: all the modes and faculties that can be known and distinguished, whether in imagination, memory, perception, or will; also the varieties and differences of all, arising from affections and other causes the most diverse; with many other subjects which require to be thoroughly scrutinized and compared in the most special manner. By these means we shall at last be enabled to arrive at sure conclusions respecting the true geometry and mechanism of this most perfect entity. And if it pleases God to accord me life and leisure, it is my intention to shew in detail at what stage of the enquiry I have myself arrived. At present I may observe in general, that I do not think it prudent to make any affirmative or positive declaration on the subject: experience and geometry alone have a right to be affirmative and positive, and when they become so, then, and not till then, by the consent of the soul, the rationale of the subject is declared. The main end of these our labors will be, to demonstrate the immortality of the soul to the very senses.

Conclusion. What is Life, but the commencement, formation and preparation of the soul for a state in which it is to live for ever after the body dies? And what this formation and preparation, but the means by which the soul, (which in intrinsic subtlety, purity and perfection, and in its capacity of receiving the divine end, is far superior and very dissimilar to the natural body,) shall continually strive to form and bend the body to its likeness; and never suffer the latter to reverse the order, or to form and model the soul. The issue, however, is by no means so easily concluded from the reason or understanding of individuals, as from the immediate acts of their will. For though reason partakes of both the body and the soul, yet it commonly inclines to side with the latter: but the will and effect demonstrate by which it is that the man is influenced. The soul has the power of feeling everything which exists by motion in the body; by virtue of which power, assisted by use and exercise, it is enabled to acquire the habit of conspiring with all the actions whereby the body modifies its state: and thus the soul is in itself the centre and ultimate mover of all things, but by habit it becomes also the prime mover, or the mover at the same time of the things occurring in that body with which it is united. Inasmuch then as the soul is formed and prepared in the mortal body for an immortal state, so we men are in this respect the happiest beings in the world, or else the unhappiest; for those who are unhappy, are more unhappy than the brutes, whose souls are extinguished, and their life annihilated, when their bodies perish. Christians again may be still more happy, or still more unhappy; for they possess a knowledge well calculated to lead to faith, and to comparative distinctness and fulness thereof: yet those of them who are unhappy, are more unhappy than the Gentiles to whom no such knowledge has been granted. Those Christians again who are learned in the divine law, the prelates and doctors of the church, are still more happy, or more unhappy; for those of them who are unhappy, are more unhappy than the rudest members of the Christian commonalty, however defective in learning and poor in knowledge and enlightenment. Among the skilful interpreters of the divine law, they again are happier still who have the faculty to engraft reason upon revelation, and to make use of both as means to a knowledge of the things conducing to faith; that is to say, they who are Christian philosophers; who, if unhappy, are more unhappy than those who have obtained their knowledge from revelation alone. For the more knowledge we possess, the more there is to make us happy, and the more to make us unhappy. Hence the Christian philosopher may be the happiest, or the unhappiest, of mortals.

THE END.

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Accident demands, not a single or simple, but a multiple causation, 16. Accidents arise from causes, 45. See *Contingency*. Accidents or chances may be admitted, yet as presupposing causes, and as flowing to a single end, they involve the existence of an infinite intelligence, ibid.

Active. Actives are incapable of forming a *contiguum;* of occupying place, or only such place as the enclosed expanse allows; the predicates of upward and downward are inapplicable to them, but they act at all angles and in all directions; and cannot be said to resist, but simply to act; &c., 103, 145. Actives cannot be finited without passives or a surface, 146.

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Animal Spirits. The vibratory or undulating motions of the elements enclosed in the frame, constitute the animal spirits, 137.

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END: see *Body*, *Delight*, *Finite*, *Infinite*, *Man*, *Nexus*. The least parts are those which mainly tend to ends, 44. The primary end of creation is for the infinite: to suppose otherwise would be to suppose contradiction or negation in the infinite, 60, 61. The final cause of creation is infinite, 62. It is obtained by finite means, viz., by the universe and man, 67. The natural *minimum* is the first end of the world, man is the last, ibid. There are many secondary ends of creation, 82. Primary ends divide into numerous secondary ends in the finite sphere, ibid. All the secondary ends conspire to the primary, ibid. Nothing can exist in a contiguous and connected entity, without coming in relation to its ends or bounds; nothing in man without coming in relation to the senses and the soul; nothing in the universe without coming in relation to the infinite, 88. The connexion of the ends made sensible by motion in the corporeal space, creates the living essence; the life being in exact proportion to the quantity of ends enclosed within the space, 120. The ends in man are the senses and sensories, and the soul; and whatever comes to the soul, stops there, as having arrived at an ultimate end enclosed in the body, and whatever so stops, man is enabled to perceive in his living space, ibid.

EXTENSION: see *Finite*. Neither modes, modifications nor contingencies are conceivable in the abstract, or without extension, 105. Whoever denies extension denies the finite, 106.

EYE, the, described, 34—36. It receives the modifications of the ether, viz., light, 36.

FAITH. The quality of faith is determined by knowledge, and where knowledge is given, it and faith are inseparable, 81, 82.

FINITE: see *Infinite*. The reasoning mind being finite, none but finite things can be known to it, 7. In postulating either the infinite, or the finite, the other perishes in the comparison, 8. In point of extension there is no ratio between the infinite and the finite, ibid. There is the same proportion (*i.e.* none) between the least finite and the infinite, as between the greatest and the same, 9. There is no ratio between the two in point of motion and celerity, ibid. The finite must have at least two terms or ends, 10, 101. It originates out of the multiplication of simples in a simple mode, or analogue of a mode, ibid, 101. The universe is finite in the whole as in the parts, 55. Though the finite is as nothing relatively to the infinite, yet the senses and reason dictate that it is something, 56. See *Nexus. Perfection, Simple.* The essence of the finite, as such, consists in subjection to degrees, and to the laws of succession and derived substantiality, 74. There are none but mechanical and geometrical laws, or the analogues of such, in the finite sphere, 95—97, 98—100. There is no finite without extension, or some analogue of, or connexion with, extension, 97—100. Nature has once for all been finited by the infinite, 98. An unextended finite could neither act with, nor in, nor upon, extension, ibid. The finite is inconceivble without attributes, consequently without form, which combined with extension is geometrical, 99. The simple finite is not the same as the pure simple; it is finite, which the pure simple is not, 101. No essential finite can produce a pure or total motion, 102.

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God. All undertakings, to be prosperous, must begin from God, 5. By the contemplation of nature we are led to an acknowledgment of God, 29. And by the structure of the human body, 30. See *Gentiles, Idolatry, Infinite, Man. Nature, Nexus, Philosophy, Revelation.* All things exist for no other final cause but God alone, 62. The distinctions in the Godhead are not finite or natural distinctions, 65, By the Only Begotten Son, who is infinite, the first finites are connected with the last, and both with God, 80.

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The infinite is not the least, or the greatest, of either geometrical, or mechanical entities, 9. The pure and simple in nature is not identical with the infinite, 9, 10. Quantity, space, motion, time, and all things, naturally and rationally declare that there is no infinity in any one of them, 11. The infinite does not exist for any rational, natural, or geometrical analysis, ibid. The infinity of God is impenetrable alike for men and angels, 12. Without the grace of God, a true and steadfast confession of infinity is not to be expected from free reason, 13. The human mind is forced by its very nature to reason on infinity, ibid. It is bound to acknowledge the infinite in answer to the question of the cause of primitive nature, 17, 22. Also in answer to the question of the least or first principle of nature, ibid. The infinite can have no cause, but is in its own cause, 18. It is *in* the cause of itself, and *in* the origin of itself, and is eternal in all time, 19. Reason may be forced on *a priori* grounds to admit the infinite, ibid. See *Nature*. The infinite, *i.e.* God, is the cause of nature, 21. See *Wonder*. We see the infinite in the perfection of the primitive, as giving birth to an orderly and harmonious universe, 25. Nothing of imperfection can issue from the infinite, 26, 27. See *Sensation*. There is a tacit consent or conclusion of human souls to the being and infinity of God, 46. The acknowledgment of the infinite is like reason itself, and comes partly from the soul and partly from the body, ibid. This acknowledgment is an action of free reason, when neither troubled too much by its own ideas, nor too destitute of all cultivation and development, 47. See *Providence*. The infinite is not to be accounted as nothing, though when compared with finites it is *quasi* nothing, 55. See *End*, *Nexus*. There are infinite things in the infinite, 57. Infinity, when affirmed by reason, is to be regarded as known in point of existence, though by no means in quality, 58. The universe was created primarily, not for the finite, but for the infinite, 62. By the Only Begotten Son, the infinite became the last effect, at once God and Man, the mediator between the finite and the infinite, 80.

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MAN was created to enjoy the delights of the world; to associate worldly delights with heavenly; to carry the world to a new perfection; and lastly, to increase the number of the angels, 30. He is so created that his subtlest part shall live in a sense above all others, 32, 43, 44. See *Delight*, *Reason*. Finite man is only a means, and not, unless in a secondary sense, an end, 63. Man is the ultimate effect in the world, through which the Divine end can be obtained, 66—70, 71, 72. All natural things concur as means to man, 68. Man is the ultimate effect, inasmuch as he can comprehend and acknowledge the infinite end of his creation; not so brute animals, 70. Hence his soul, and the necessity of his reason, which is the conjunction between the soul and the body, ibid. In man dwells the veriest final cause of creation, 71. There must be something divine and infinite in the finite man, otherwise the infinite could have no cause respecting it in the finite, ibid. This something does not lie in the human senses, soul, or reason; but in the fact that man acknowledges and believes in the existence and infinity of God, and by faith, feels in love, and its delight, a connexion with the infinite, 71, 72. Man, with all his parts and his very soul, is finite, 72. He may concur to dispose himself for the reception of the infinite end, ibid. Nothing superlatively perfect in a finite sense can exist in man, as he is finite and many times finite, 75. But see *Soul.* By the Only-begotten Son alone are we ultimate effects to the primary end, 80. See *God.* In man as a natural being none but mechanical and geometrical laws are possible, 100.

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Mutation. No perceptible operation can take place between the soul and the body, without a previous mutation in the animal *contiguum* or living space of the body, 120, 121. No mutation can happen in the natural sphere without motion, 121. See *Motion.*

Nature. The first natural entity is a causate, but not in the same sense a cause, 17, 21. It must originate from the infinite, 20. It is the seed and principle of all natural things, and has in it, in its own manner, everything that can exist in nature, ibid., 21, 24, 44, 45. All things issued from it in natural order, ibid., 24. Nature is the second cause of the world, and not the first, 21. It is impossible to grant too many details respecting the involution of causes in the primitive entities of nature, ibid., 44. See *Cause*. All nature was once contained in the least first principles, 24, 44. The greater worshippers of nature we are, the greater worshippers of God may we become, ibid. Nature and not God is the cause of imperfection, 27. There is nothing natural but is also divine, and nothing should claim admiration as natural, but only as divine, ibid., 87. The natural is only obedience, and not even that, inasmuch as the obedience is necessary and compelled, ibid. We may fairly attribute [causation] to nature, ibid. Nature derives from the infinite no conditions but those of superlative similarity, perfection and purity, 75. Whatever exists from the primitive seed of nature to her largest compound, in a word, the totality of the finite sphere, is all natural, 87. The primitive is made natural by God immediately; other substances are made natural by Him mediately; therefore the natural is mediately divine, ibid. Nature has none but geometrical and mechanical laws, 105.

NEXUS. See *Connexion*, *Finite*, *God*, *Infinite*, *Simple*. There is a nexus, but an infinite one, between the finite and the infinite, 57, 60. This nexus regards not only existence but essence, 60. We cannot deny the nexus without destroying the finite, ibid. The nature of the nexus is as unknown as that of the infinite, 60, 61. Without this infinite nexus, the finite, as the end, would have no relation to the beginning; as the last cause, no relation to the first, 61. The nexus is neither mechanical, physical, nor geometrical, 63, 64. The nexus is to be regarded as positive and affirmed, though its qualities are unknown, 64. The nexus, affirmed by reason, is also given in Revelation; *i.e.*, the Only-begotten Son, ibid. The connexion between the infinite and the finite is through the Son of God, Himself infinite, 65. See *Body*. The Only-begotten Son furnishes a nexus between the infinite and the finite on the part of the body, 79. The instance of the soul and the body throws some light upon the connexion between the infinite and the world, 87. The nexus between the soul and the body has its limits or ends included in the bodily space, 119. In the microcosm, man, there is a membranous as well as an elemental nexus running without a break from the body to the soul, 140.

PERFECTION. What God produced immediately could not fail to be superlatively perfect, 26, 73. See *Primitive of nature*. God is not even remotely the cause of imperfection, ibid., 78. The first finite cannot be absolutely perfect, though finitely most perfect, 73. The eminent perfection of the primitive has innumerable particulars as its grounds, ibid. All the leasts of the world are finitely most perfect and self-similar, ibid. The perfection of primitives necessarily decreases by degrees and series in derivatives, consequences and compounds, 74. Were all things, from first to last, equally perfect, or most perfect, the finite could not exist, ibid. See *Similarity*. In this case perfection would not be finite, and would not involve all its own series, of perfect, more perfect, most perfect, ibid. There are necessarily finiteness or degrees in finite perfection, 75. Derivatives are perfect in proportion as they are near to the primitive, ibid. See *Man*.

PHILOSOPHY, when truly rational, connot be contrary to revelation, 3, 4. Philosophy has its own sphere, and will not be dispossessed of it by theology, 6. See *Infinite*. The human mind, when free from cares and opposing circumstances, is ambitiously philosophical, 7. The persistency of the philosopher in this respect, is unavoidable, natural and human, 13, 59. We are in duty bound to meet the erring philosopher by his own philosophy, 14, 59. But we cannot vanquish the sceptical philosopher with his own arguments, ibid. See *Idolatry*. The failures of philosophers in their ideas of God, are due to their making the qualities of the infinite an object of investigation, 51—54. The philosophers admire the last result of thought as God, seeking their deity from the ground of mere admiration or ignorance, 52. Some philosophers, to identify God with nature, have supposed the latter to be infinite and eternal, 54, 65.

PRIMITIVE OF NATURE. All future things were present, and inexistent in act, in the primitive entity, 26. Nothing but superlative perfection can reside in the primitive, ibid. There can be no mean between the infinite and the primitive, 59.

PROVIDENCE, in the infinite, cannot be separated from providence, 50, 76. God's previdence and providence are instantaneous, coincident, and infinite, ibid., 76.

QUANTITY. There is no quantity infinitely small, 8.

REASON is a faculty partaking of both the soul and the body, 3, 72, 142. Man is to perceive by it what things are revealed, and what are created, 4. The rational cannot be contrary to the divine, nor the mysteries above reason, contrary to reason, ibid., 86. The use of reason in treating of God, the soul, &c., is legitimate, unavoidable and laudable, 14. It is not safe to seek causes and reasons from any other source than reason, ibid. Reason is the fruit of the intercourse between the soul and the body, 72. See *Man*. Truly rational theology will never attempt to penetrate into the mysteries of infinity, 86. Reason is superadded to the senses, to enable us to infer the nature of causes and effects which are above the senses, 97. Reason should begin where the eye ceases, 133. Rationality is never the product of the soul alone, 142. See *Revelation*.

REVELATION: see *God, Philosophy, Reason*. Revelation discovers much whereby man may finitely conceive and express God; though no finite perceptions and expressions can be similar or adequate to God, but may be simply not repugnant, 58. Revelation and reason, natural theology and revealed, must mutually aid and assist each other, 85.

SCRIPTURE. What is proved by Holy Scripture, needs no proof from reason, rational philosophy, or geometry, 13.

SENSATION. There is no sense without nerves, and there is no mean to sense in nerves but motion, 42. We are better led to acknowledge the infinite by effects and the senses, than by the other ways or methods of the soul, 46. The end of the senses is, to lead us sensually to an acknowledgment of God, ibid. All sense owes its existence to the soul. See *Author, Delight, End, Soul.*

SIMILARITY: see *Mode, Nature, Perfection.* The superlatively perfect self-similarity of the primitive entities, becomes gradually less and less in derivatives, 75, 116. The similarity of the parts of the subtler sphere, implies their perfection both in substance and mode, 117. Similars are less obnoxious to mutability, ibid.

SIMPLE. The simple principle of nature has only one limit, and therefore is not finite, 10, 100, 101. See *Infinite*. The simple is not otherwise derivable than immediately from the infinite, 18, 60. Time and succession cannot be predicated of the pure simple, but in point of origin it is instantaneous, yet not eternal, but in a manner before time, 19. See *Finite, Perfection*. The soul is not a pure simple, 100. The simple alone, which is neither infinite nor finite, can produce pure and total motion, 102.

SOUL, the, is given to the body out of the purer and more perfect world, 72, 76, 77. And this, of God's foreknowledge and providence, to ensure obtaining the primary end of creation through otherwise imperfect man, 76, 77, 79. The soul of the first man was superlatively rational and perfect, 77. The soul is intended to make the body in its own likeness, and to give it its own perfections, ibid., 148. The soul must be instructed by the senses, to enable it to instruct the body, and both to tend to the primary end, 83. All the faculties of the body are mediately the property of the soul, but distinct rationality is its immediate minister and effluence, 87, 88. The soul and its spirits *(spiritus animales)* are finite, 93, 104. The soul is amenable to laws, and these also are finite, 93, 94. The soul can adapt itself to the body, be formed afresh, and take upon it the likeness of the body, and still the members obey its operation, 94, 141, 144, 148, 149. Distinct quality is predicable of the soul, especially as it is united and limited to a particular body, ibid. The soul is not a pure simple, 100. Nor a simple finite, unless activity be regarded as involved in such finite, 102. The soul must be capable of being confined to its own body; hence it cannot be purely active, but must have a passive surface or expanse, to enclose or shut in its actives, 102—104, 146, 147. This secures its actuality and permanence, not only in the body, but after its release from the body, 103. See *Active*. The soul is bound by geometrical and mechanical laws; it is in nature, and is natural, and a part among the physical constituents of the body, 104, 105, 108. The soul may be justifiably regarded from animate machines, 107. The soul is immortal by the grace of God, and its mechanical nature does not impugn its spirituality, ibid, 108, 112—117. Self-similarity reigns among all the parts of the soul, ibid. It is naturally impossible that the soul should die, as there are no elements in nature to harm it, 108. There is no reason to despair, like the philosophers, of attaining a knowledge of the soul, 108—110, 147. Ignorance of the state of the soul may easily lead to denial of its existence, 110—112. See *Motion*, *Mutation*. By the use and employment of discordant modes, the soul may become assimilated to the grosser world, and its harmonies become discords, 141. In this case, after death, the presence of aught from the purer world will give it painful misery, ibid. The soul is the centre of the bodily motions, 142. It performs its analysis upon them in its own pure and self-similar sphere, and rests therein harmonically and delightfully, ibid. The soul is primarily seated in the cortical or cineritious substance of the brain, where the membranes assume their finest attenuations, 143. The soul is self-similar wherever it is, and is formed according to the motion of the middle membranes, 144. The soul is of different formation in different brains, ibid. There is generally, though not always, a similitude between the soul and the body, 145. The soul is neither elemental nor membranous, but a most active essence; not unlike the actives mentioned in our *Principia*, 145. See *Active*. Actuality in the soul involves modes, and these must be referable to substances, 146. The membranous surface of the soul must have a centre, by which, and the distances from which, all that is most distinct may exist, 147. See *Souls of Animals*. We may arrive at a knowledge of the soul, if we assume that its actuality consists in a motion and power supremely mechanical, and its surface in a figure supremely geometrical, and afterwards examine experience, relative to all anatomy, all the mental faculties, their differences, &c., and many other subjects, 148. The state of the soul is more easily concluded from the actions of men than from their reasons, ibid.

SOULS OF ANIMALS, the, are formed in the likeness of the human soul, but they are gross and elemental, and do not consist of the actives which constitute the actuality of reason, but have an elemental ground, 147.

TERMS. When high subjects are treated, all expressions that can make the reader pause, should be avoided, 3.

TIME involves the mechanical element, and is similar to the geometrical, 11. See *Infinite*, *Simple*.

VIBRATION. All vibrations tend naturally to run in circles and curves, 40. They love spiral, circular and hyperbolic curves, 42. See *Ear*, *Element*, *Hearing*. The vibration of membranes is always as the distance from the centre, &c., &c., &c., 137—139.

WONDER: see *Cause*. We wonder at the causes and leasts of things, as involving the quality of producing, more than at the products or ultimate things themselves, 23, 24, 25. Wonder rises to higher powers in contemplating causes, ibid., 24, 25, 29, 30. The closing wonder is felt when we acknowledge the cause of the least in the infinite, ibid., 24, 25. We do not wonder at the cause of nature merely as a cause, but as an infinitely intelligent cause, 24.

WORSHIP. There is nothing, whether dead or alive, but adores and worships God, since all things tend to obtain the divine end in the ultimate effect, 83.

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MISCELLANEOUS OBSERVATIONS

CONNECTED WITH

THE PHYSICAL SCIENCES.

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INTRODUCTORY REMARKS BY THE TRANSLATOR.

THE *Miscellanea Observata*, of which a complete translation is now for the first time submitted to the English reader, was published at Leipsic in 1722, in three Parts, to which a Fourth Part, published in the same year at Schiffbeck near Hamburgh, was subsequently added. Owing probably to its small size, and separate publication, the Fourth Part has become exceedingly scarce, and indeed it is a matter of congratulation that even a single copy could be procured for the completion of the present work.

The *Miscellanea Observata* were noticed in the *Acta Literaria Sveciæ*, 1722, and reviewed at greater length in the *Acta Eruditorum Lipsiensia* for May, 1723, p. 263, and June of the same year, p. 96. An able translation of the sexagenary calculus* appeared in the *Gentleman's Magazine* for September, 1754; pp. 423, 424, and two of the original papers in the Appendix were translated in the *Acta Germanica*, London, 1742.

These are the chief periodicals in which the *Miscellanea Observata* have been noticed, for we are compelled to pass over the *Historie der Gelehrsamkeit* (History of Learning), which appears also to have reviewed them, as it has shared the same fate as its anonymous composers, and has departed from the memory of men. This review appears to have been actuated by a minute spirit of criticism, which is not entirely lost at the present day, and to have taken more notice of the typographical errors, than of the views set forth in the essays. It must, however, in candour be acknowledged, that there was no scarcity of errata; for at the head of a long list of alterations and omissions there is a notice to the reader, that "as innumerable typographical errors have crept in, owing to the negligence of the person appointed to revise the press, the volume scarcely admits of correction; the reader would therefore do well in throwing it aside, as a revised edition would shortly be published."* This second edition probably never appeared.

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* This new calculus is mentioned at greater length in a letter to the Rev. Dr. Nordberg, which is given in the appendix to his "History of Charles XII." A translation of the French abridgment of the original letter may be seen in the *Intellectual Repository*, May, 1842, pp. 161—165.

Let us, however, pass from the errata, which affect the sense materially in but very few instances. The work embraces a great variety of subjects, geological, scientific, mathematical, and mechanical, together with several suggestions for improvements in different branches of the arts. In all these papers, the acute observation and practical sagacity of the author are conspicuous; and if a few of his deductions may be considered as somewhat questionable, others have since been corroborated by modern researches.

But it is not only in a scientific point of view that these papers are interesting. Although many of the theories are highly ingenious, and carefully supported by experiments and observations, as accurately performed as the state of science at that time allowed, they will be considered by some readers as chiefly valuable in shewing the extraordinary industry and abilities of the author at a comparatively early period of his life. As an additional proof of the extent and versatility of his powers, we shall subjoin a brief account of the several works and treatises mentioned in the *Acta Literaria Sveciæ,* vol. i., extending from the year 1720 to 1724.

1. (page 5.) Om Wattnens Hoegd, och foerra Werldens starka Ebb och Flod, Bewis utur Swerige. Stockholm, 1719, 8vo., pp. 40.

Arguments derived from appearances in Sweden in favour of the depth of the waters and greater tides of the sea in the ancient world.

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* "Errata typographica, quia innumera, negligentiâ correctoris irrepserant, vix emendare vacat: quorum ob causam impressionem hanc rejicere debet Lector, aliam emendatiorem propediem habiturus."

2. (page 22.) De Monetarum Mensurarumque Ordinatione Decimali.

On the Decimal System of Monies and Measures, to facilitate calculation, and abolish fractions. This work was published in Swedish with the following title, "Fôrslag till vårt Mynts och Måls Indelning." Upsala, 1719, 4to. In the Catalogue of the Upsala Library, another edition of this work in octovo, 1795, is mentioned.

3. (page 26.) De Terræ Planetarumque Motu atque statione. Skara, 1719, 8vo.

On the Motion and Position of the Earth and Planets.

This treatise was published in Swedish, under the title, "Om Jordenes och Planeternas Gång och Stånd."

4. Dædalus Hyperboreus, sive nova Experimenta Mathematica et Physica. Upsaliæ, 1716, 1717, 1718. 4to.

This work, consisting of new experiments in mathematics and physics, by Swedenborg and several of his scientific friends, was published in six parts, all of which are in Swedish, but the fifth part has a Latin version also.

5. (page 27.) Foersoek, att finna Oestra och Westra Længden igen, igenom Månan. Upsala, 1718, 8vo., pp. 38.

Attempts to find the Longitude of Places by Lunar Observations.

This is the original Swedish edition of the work subsequently published in Latin at Amsterdam in 1721, and of which a translation has been given in the *Principles of Chemistry, with other Treatises.*

6. (p. 111.) Om Vennerns fallande och stigande.

On the rise and fall of Lake Wenner, with an accurate sketch of the cataracts of the river Gotha Elf.

This is a manuscript dissertation of Swedenborg's, founded on various observations transmitted to him in letters by scientific persons. The article in the *Acta Literaria* does not mention whether it was ever printed, nor is the size of the dissertation stated. Reference is made however to page 79, and the review would lead us to suppose that the original treatise was a very interesting work.

7. (page 126.) Regel-Konsten författad i Tijo Bökker, &c. Upsala, 1718, 8vo., pp. 135.

Algebra, or the Art of Rules, comprised in ten books, &c.

This work is reviewed at considerable length, and is mentioned with great honour—not only because the author was the first Swede who wrote on the higher branches of the subject, but for the excellence of the treatise itself, the clearness of the language, and the examples shewing the application and uses of the rules. Each book is divided into three parts. The following is a very brief outline of the contents of this work.

Book I. contains the definitions and explanations of the terms employed, and the simpler arithmetical processes.

—— II. The mechanical powers, the lever, pulley, inclined plane, &c., with a variety of problems.

—— III. The laws of proportions and ratios; also with numerous problems.

—— IV. Geometrical theorems, stereometry, and specific gravity.

—— V. The properties of the Parabola and Hyperbola.

—— VI. The properties of the Parabola more fully considered, with numerous other problems.

—— VII. On the theory of Projectiles and Artillery, with many problems.

—— VIII.
—— IX. } On adfected Roots, and on the integral and differential Calculus.
—— X.

8. (page 192.) A letter (on the Primeval Ocean) to Jacob a Melle.

9. (page 209.) An announcement of the treatises comprised in the volume of *Chemical Specimens*.

10. (page 282.) Novæ Regulæ de Caloris conservatione in Conclavibus.

New Rules for maintaining Heat in Rooms.

11. (page 302.) A notice of the publication of the treatises mentioned at p. 209, and also of the first Three Parts of the *Miscellanea Observata*.

12. (page 353.) Expositio Legis Hydrostaticæ, quâ demonstrari potest effectus et vis aquæ diluvianæ altissimæ in saxa et materias fundi sui.

An Elucidation of a Law of Hydrostatics, demonstrating the power of the deepest waters of the Deluge, and their action on the Rocks and other Substances at the bottom of their Bed.

13. (page 366.) Another notice of the treatises mentioned at p. 209, and of the *Miscellanea Observata,* including the Fourth Part.

14. (page 588.) Camena Borea cum Heroum et Heroidum factis ludens; sive Fabellæ, Ovidianis similes, sub variis nominibus scriptæ ab E. S. Sveco. Gryphiswaldiæ, literis Dan. Ben. Starckii. 1715. 8vo.

15. (page 589.) Fabula de Amore et Metamorphosi Uranies in Virum et in famulum Apollinis; ad illustrisimum et excellentissimum R. S. Senatorem, comitem Mauritium Wellink. Naupotami, typis Herm. Henr. Hollii, 1722. 4to. carmine elegiaco.

Of the above, three are original papers by Swedenborg; and as they are of the same character as the *Miscellaneous Observations,* it has been deemed advisable to add them in the form of an Appendix.

Considerable difficulty has been experienced in translating the various terms employed in the papers on geological subjects. Owing to the numerous distinctions introduced by the researches of modern geologists, many of the old expressions are no longer in use, and others have been considerably modified in their significations. In the infancy of the science, the same terms were much more comprehensive in their application than at present: for instance, all rocks consisting of small grains, were formerly included under the name of granite, a term first used by the Italian geologists, and literally signifying *grained* [*granito*]. Rocks of very different natures were thus classed together; but as science advanced, distinctions were gradually introduced, which render the observations of the earlier geologists no longer exact in modern phraseology. Cronstedt, who wrote in 1758, says that granite occurs on the summit of the Kinnekulla; but Sir Roderick Murchison has lately ascertained that it consists, in fact, of eruptive trap. This difference is owing to the greater precision which has been observed in the respective terms: in Engeström's translation of Cronstedt's

"System of Mineralogy," London, 1772, the Swedish *gråsten* is rendered granite: and Wallerius, in his "Systema Mineralogicum," 8vo., Vindobonæ, 1778, (vol. i., p. 421—441,) describes no less than five distinct kinds of rocks, comprising fifty or sixty varieties, all of which are included under the Swedish term *gråsten*, or *gråberg*, although their composition is widely different. The *saxum griseum* (*gråsten*) of our author, will therefore require rather an extensive application; but may generally be considered as representing the various rocks from the granitic to the trapean formations; amongst the latter of which the modern *graustein* is classed by Werner. The *graustein*, however, is not very accurately defined, even at present; according to Brochant, it is composed of very small grains of white feldspar and black amphibole, whilst Heidinger and Blumenbach consider it as an argillaceous porphyry. Several of these rocks occur in strata, and formations of stratified granite have been discovered, of which De la Beche mentions an example at Weinböhla, as existing above chalk; which might be adduced in support of its aqueous origin.

We may perhaps be allowed to give a short account of the ætites, belemnites, boles, and entrochi, all of which terms occur in these *Miscellaneous Observations*.

Ætites, or eagle stones, (from ἀετὸς, an eagle,) were so called, because they were supposed to be found in eagle's nests. They are hollow stones, containing a nucleus, which rattles on being shaken, like a nut in its shell. They were formerly considered to possess several extraordinary medicinal, and even magical powers.

Belemnite, or thunder-stone, (from βέλος, a dart,) is a fossil of an extinct order of Cephalopoda, occurring amongst marine remains in marble, limestone, and chalk. Its form is cylindric, or rather it is part of a very acute angled cone. When exposed to a red heat, it emits an odour like that of burnt horn, which led some of the ancients to imagine it to be one of the materials of the thunderbolt. Others, however, believed that it was of animal origin, and that it was produced by the lynx; it was, therefore, occasionally called the lynx-stone.

Boles were of different kinds; the most important was the

Armenian bole, a hard and compact earth, of a bright red colour, somewhat inclining to yellow. It was employed in distilling sea salt and nitre; in which operation, the sulphuric acid it contains acted on the alkaline bases of those salts, and liberated their acids. Other kinds of boles were neutral, or alkaline, and were used as colouring matters.

Entrochi are the fossil remains of some extinct marine animal of the asteriæ kind, probably the petrified arms of the sea star fish, (stella arborescens.) They are generally cylindric columns, about an inch in length, consisting of a number of small joints, like so many segments of a cylinder. The entrochus pyramidalis is a common fossil in Sweden.

The papers on the Elementary and Bullular Hypotheses are evidently the first ideas of the theories afterwards so ably developed in the *Principia*,* to which the reader is referred for additional confirmation. The *Principles of Chemistry*† likewise throw considerable light on several of the subjects treated of in these pages; and in their turn, they also derive support from the theories and experiments in these *Miscellaneous Observations*. So true it is, that the same idea of thought runs through the whole of the author's philosophical writings, susceptible of amplification and expansion; so that as our facts increase, they may each be arranged in their proper place and order; of which, indeed, several recent discoveries in the higher departments of science are remarkable illustrations.

The question has been asked, but chiefly by those who are unacquainted with any of the writings of Swedenborg, What is the object of publishing works on science which have been so long buried in the dust? Is any benefit to be expected from reviving them? To this we may reply, that the first and principal object is, to obtain a complete edition of all the works of Swedenborg, that by his own merits he may be judged, and either fall or stand, according to the result of the investigation. The case is similar to that of the works of Lord Bacon, of which complete editions have been published, (notwithstanding that some of the views advanced are far more open to the charge of error than any in our author's pages,) in order that a correct idea may be formed of his extraordinary powers, and the general tendency of his philosophy; as it is justly considered, that the errors and mistakes into which he may have fallen, are not to be weighed against the solid gold which shines throughout his works. Such also is the opinion which should, and in due time will, be formed of the writings of Swedenborg, and of the character of their author.

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* *The Principia; or, the First Principles of Natural Things, being New Attempts toward a Philosophical Explanation of the Elementary World; by Emanuel Swedenborg.* Translated from the Latin, by the Rev. A. Clissold, M.A.

† *Some Specimens of a Work on the Principles of Chemistry, with other Treatises, by Emanuel Swedenborg.* Translated from the Latin, by Charles Edward Strutt.

A second reason for publishing the scientific works, is, that they are essentially different in kind from those of the present day. The views they advance are exceedingly suggestive, and appear capable of uniting all the sciences into one harmonious whole. Although at present only a few points are indicated in the great circle, enough has been done to trace the outline; and it is to be hoped that ere long, the labours of a new science may complete its beautiful proportions.

On these subjects, however, this is not the place to enter; and therefore, it only remains respectfully to submit this volume to the consideration of the numerous and rapidly increasing readers of these works, both in this country and in America.

London, June 1st, 1847.

To the most noble COUNT GUSTAVUS BONDE, *President of the Royal Metallic College of Sweden.*

MANY reasons induce me, most noble Count, to request your patronage for this work. In addition to occupying the Presidency of the Royal Metallic College, you are deeply skilled in mathematics and physics; which you owe to a happy combination of great abilities with equal industry; whereby you doubly deserve the laurels which Sweden has bestowed upon you. If, then, these Miscellaneous Observations should gain your approval, it will be accepted as a sure sign that the same meed awaits them from the learned world, by,

Most noble Count,

Your most obedient and humble Servant,

EMANUEL SWEDENBORG.

MISCELLANEOUS OBSERVATIONS

CONNECTED WITH

THE PHYSICAL SCIENCES.

PART I.

MISCELLANEOUS OBSERVATIONS.

PART I.

On the different kinds of Mountains in Sweden, with a disquisition on their origin.

It is important to note the various positions, differences and characters of mountains, as clearly indicating the effects of the universal Deluge. In Sweden, there are mountains, 1. which lie in strata, consisting of white clays, sand, scissile, calcareous and many other kinds of rock, generally arranged in layers. Many mountains of this kind are seen in East Gothland, West Gothland, Gothland, and almost every other province of the kingdom; they are frequently from three to ten miles in length, and from a quarter to half a mile broad. 2. There are other mountains composed partly of strata, and partly of granite *(saxum griseum)*; in West Gothland we meet with examples in which the upper crust is formed of common hard granite, with strata of scissile and calcareous stone underneath it. 3. Some mountains, of considerable size and extent, consist of pure clay of different colours, and others of pure sand. 4. Some are formed of sand, intermixed with pebbles; the latter round and polished, as if turned in a lathe: immense mountains of this description, frequently a hundred and fifty ells* in height, are observed in Westmannland, Dalekarlia and Upland. 5. Others appear to consist of pebbles only, without any sand, all most curiously turned. Great chains of this kind exist in different parts. 6. There are many which seem to be formed of enormous stones, like fragments of mountains piled together: I have frequently perceived them at a distance of several miles, although their breadth seldom exceeds more than from thirty to fifty paces; their sides are generally very precipitous. The spectator may well be astonished on finding that these ridges, from the very bottom upwards, consist solely of the large fragments just mentioned, all mingled together, and each probably weighing from ten to forty Swedish naval pounds *(skeppund)*. Nor must we omit to notice, that the provinces are strewn with these vast boulders, like pieces of mountains, even where there is not a hill in the neighbourhood; notwithstanding which they are often found in the plains, at the bottom of lakes, even on the very summits of other mountains, which may appear paradoxical to those who have not had opportunities of observing the same in their own districts. The province of Helsingland and the district of Orebro are full of these remarkable specimens, spread like buildings over the level country. 7. Nor must we omit those mountains that consist of common hard granite; some of which are divided into strata, but comparatively large and unequal, whilst others again are not stratified; this kind of rock or mountain is seldom found elsewhere. 8. Adjoining the latter there are also calcareous and silicious mountains of different colours, and mountains of chalk and limestone. 9. Besides different kinds of minerals, impregnated with copper, iron and silver.

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* The Swedish ell is equal to 1 foot $11\frac{7}{19}$ inches English measure.

It may further be observed, that the ridges of most of these mountains, both of those which are stratified and of those which consist of accumulated heaps of sand, pebbles, stones, &c., run north and south. 2. Their sides are generally shelving, but the degree of the slope appears to be influenced by the substances of which they are formed; those consisting of sand are not so steep as those formed of large masses of stone, which may be accounted for by the slipping of the sand. 3. In West Gothland, there is a mountain called Kinnekulla, one of the loftiest in Sweden, of a pyramidal shape, rising at first in a gentle slope from a broad base, and gradually shelving until at last towards the summit its ascent becomes quite perpendicular. This mountain is situated between two others that run north and south, called Billingen and Hunneberg, which seem like ramparts to the Kinnekulla, the latter appearing to have been formed in their very gorge, within their projecting lips; as if the water had burst through the aperture, and at length standing between them, had deposited the argillaceous sediment or matter that it brought with it; adding stratum after stratum with every fresh current, until the mountain reached the present altitude. On another side, the great lake Wenner lies at its base, and presents a hollow corresponding to the elevation of the mountain. We need hardly speak of the different substances of which the latter is formed, further than to remark, that the base itself consists of limestone strata of different kinds and colours, succeeded by scissile argillaceous, which in some places is as perpendicular as a wall; then we have the harder scissile and black calcareous rocks; some part also consists of the common granite. Pyrites and various other stones are also found there; the pyrites, in particular, is very rich, and deserves to be classed amongst the rarer ores of Europe.

From the above facts we may conclude that all these formations have been produced in some very deep or universal diluvian ocean, which is proved by the following considerations. 1. The mountains consist of substances of such different kinds, as sand, clays, smooth pebbles, large stones, and masses of rock. 2. Their slopes indicate that they were thrown up by the sea into great accumulations, and so formed into lengthened ridges, with shelving sides. 3. These ridges run north and south; which shews that the same winds prevailed in the diluvian as in the present ocean. The cause of the variation of the winds in the inland seas, (for example, in the North Sea, the German Ocean, the Baltic, the Mediterranean, &c.,) seems to be owing to the neighbouring shores and countries, by which the winds are turned, or compelled to alter their direction; this however is not the case in the Ocean, where the winds are known to blow nearly always from the same quarter, and indeed generally from the east or west. If, therefore, such large masses and accumulations of clay and sand could be moved by the power of the sea, this must necessarily have taken place under the influence of these easterly and westerly winds, which would determine the direction of the mountain chains: and this indicates that the ocean we are speaking of was universal, and stood at a great height above the land, and had no limits, shores, or straits to warp the winds, or cause them to blow to new and unusual quarters.

But should the reader ask how the ocean could carry away stones of so vast a size, and pile them together, he will find his answer in the principles of hydraulics. It is well known, 1. That water presses according to its depth; so that its pressure on bodies or stones at the bottom is greater at a considerable than at a small depth; which indeed cannot be denied. 2. It is likewise known, that when the sea is in motion, not merely the water on the surface, but that at the bottom also, rolls and fluctuates; when therefore a tempest arises, the bottom is often thrown upwards, and the water rendered turbid; in the same way as in the atmosphere in which we live, we perceive that the air is in commotion, and driven into waves at the bottom, as well as at a greater height. 3. If therefore the waves give an impulse to the sea at the bottom, and water presses according to its depth, it follows that the water rolling at a great depth, is carried on with greater force and weight, in the same way as a large and heavy ship strikes against any obstacle with greater violence than a small or light vessel, though constructed of the same kind of timber. A wave at the bottom of the sea acts in a similar manner, and owing to the power derived from the weight of the superincumbent water, rushes with a greater impetus against any masses of stone, or other obstacles, and carries them away with facility. 4. Therefore, as the bottom of the sea was covered with different sorts of stones, sand and clay, it is by no means extraordinary that a wave of very deep water continued towards the bottom should have had sufficient power to bear away in its current stones of enormous bulk, and after having torn them away from their foundations, to strew them about in heaps, or pile them into mountains, and thus to form ridges, or cover whole provinces with them. 5. Hence we see that mountains of this description generally extend from north to south, that they contain stones that have been rubbed and polished, mixed with sand, and scattered about in various directions. 6. These stones also exist in the greatest quantity in those places which are now at the highest elevation above the sea, as in the province of Orebro, which is situated between two seas, at a great height above their present level; namely, from seventy to eighty Swedish ells, in which province they are indeed most abundant. The reason of this is, that as they could only be moved by the deeper waves, if the sea had sufficient power to carry them to the highest parts of this district, they would necessarily stop there, and travel no farther, since the force in the water diminishes with its depth. 7. This view appears to be confirmed by calculation; for stone is heavier than water in the proportion of about 2½ to 1: but when placed in water, it loses a part of its weight equal to 1, so that in this case, it only weighs to that element as 1½ to 1; and still less in salt water. When the bottom of the sea, therefore, is agitated, it follows that the deeper waters possess sufficient power to transport weights hither and thither, although heavier than water in the proportion of 1½ to 1: as is indeed proved by torrents, which frequently tear away masses of stone, and overthrow walls of solid masonry. Dykes, though built of stone, are overthrown when the water rises three or four ells higher than usual, owing to the power which it immediately gains by the increase of depth, as I have myself known to occur in Sweden a hundred times. Another proof is afforded by the power of our atmosphere, which carries away bodies a thousand times heavier than itself, and conveys them to a great distance. Do we not often see heaps of sand whirled off in a storm for a thousand paces? Also dust, wood, bark, trees, and many other bodies a thousand times heavier than the atmosphere? This appears to be owing both to the increased area of small bodies, and to the weight of the atmosphere moving at the bottom, *i.e.* on the surface of the earth. In a similar manner the Ocean, in gales of wind, produces an irregularity, often extending for miles, in its shoals and sand-banks, and likewise at its own bottom. If then the atmosphere, though a thousand times lighter than water, can exert such a force on heavy bodies, as to transport them from place to place, what must have been the power of this mighty and ponderous ocean? This gives us some glimpse of the origin of mountains; provided the cause assigned is worthy to be accounted geometrical.

On the Petrified Plants found at Liège.

Although at the present day large collections have been made of different kinds of petrifactions, it may notwithstanding be desirable to notice certain plants found in vast quantities at Liège, in one of the strata of a mountain situated near the monastery of the Chartreux. It is to be observed, 1. That the stone in which they were found is a soft scissile of a brownish grey colour. 2. This mountain rises about seventy ells above the city of Liège, or about eighty above the river which runs through the city, so that we may fairly calculate its height at about a hundred ells above the present level of the sea, if we take into consideration the descent of the river towards the sea. 3. The ridge or back of this mountain lies nearly north and south. 4. The stratum inclines from west to east at an angle of about sixty degrees, like the other strata. 5. The vegetable stratum is of considerable thickness; on one side of it there are layers of sandstone, and yellow clay; at another side there is the same argillaceous scissile as the stratum itself; on the third, we have fossil coal of the best quality; and on the fourth, the road. 6. On their upper surface, these sloping layers are covered horizontally with a black stratum which runs toward the fossil coal; above this, with a layer of white clay, next with yellow clay, and lastly with the soil. 7. And what is more remarkable, the whole of this stratum is filled with vegetable remains, and in every few pieces of the stone we can hardly fail to find petrified stalks and leaves; indeed, it might appear as if a number of haystacks or part of a wood had been rolled down hither by the sea. This furnishes an indubitable evidence that an ocean formerly stood at a height of at least a hundred ells above the level of the present sea; an ocean which uprooted the inhabited land with its fruits and herbs, and promiscuously mingled sand, clay, and rock in vast accumulations.

The vegetable specimens to which I have alluded, were collected by myself and my travelling companion, Doctor John Hessel, physician to the province of West Gothland, and well skilled in the botany and fossils of Sweden. They are as follows:—1. ACFO are all leaves of nearly the same species, except that some have the stripes running obliquely upwards, which in others are horizontal, or parallel. 2. DJPQR are, as I suppose, leaflets from these stalks, but of a larger size, particularly the specimen P; in the leaflet E the stripes are oblique. 3. B is a small branch. 4. G and K are leaflets. 5. Innumerable petrifactions of stalks and stems were observed. 6. H is a piece rounded on two sides, with straight grooves proceeding from a certain small line. 7. L has the appearance of an ear of Indian corn, or maize, except that it is flat. 8. I am in doubt whether M be the scales of a fish, or the fruit of a tree. 9. N is a species of Belemnite. The same fossils are still found in this stratum, and whoever pleases may procure thousands of specimens.

On the Strata of Shells at Aix-la-Chapelle.

In further proving the existence of a diluvian ocean from mountains and mountain strata, we can have no clearer corroboration than is afforded in the high mountain of Lousberg, situated near Aix-la-Chapelle, on the north. 1. This mountain rises about eighty ells above the city, and about a hundred above the level of the sea. 2. It consists in a great measure of sand, which, on external examination, we should confidently assert was hard stone, as it has the colour and form of stone, and may be removed in square blocks. On examining it internally, we observe the same graining and arrangement of particles as in the stone, shewing, unless I am mistaken, that this mountain has been softened into sand. 3. The top of the mountain on one side consists of sand mixed with earth; under this we have a layer of pure calcareous pebbles, but very unequal in size; and next, a layer of perfectly white stone, divided into square masses, exactly like entire limestone. 4. Then comes another layer of very irregular stones, flints, &c. 5. On another side the mountain consists of sand, and shells of various descriptions. 6. A stratum of sand then follows, and next an intermediate layer of shells. 7. More than ten layers of the latter may be counted, some an ell in thickness, others a half, a third, or a quarter of an ell; the distance between them being from one to three ells, while the intervals are formed of pure sand. 8. I have figured these shells, of which we found more than thirty in one piece of the stratum; which piece indeed seemed like a conglomerate of them; but owing to the difficulty of separating them from the stone in a perfect condition, I have only shewn the principal ones.

Amongst the whelks, oysters, and other bivalves, there are, 1, some, as Fig. T, with oblique lines or furrows, and granules distributed along them. 2. Some, as Fig. G, have the lines or stripes without the granules. 3. Others have fine lines of two kinds, as Figs. F, Z, M, H. 4. BD, &c., are univalves. 5. One shell filled with smaller ones, and containing a turbinite, is shewn in Fig. E. 6. Figs. S, X, C and W, are turbinites of various descriptions. 7. Y is a mass of little worms. 8. Fig. K is the shaft of a reed. 9. Fig. R, little shells.

It is also observable that, 1. Some of the strata and shells are very soft, and whitish yellow; some are red, or brown: some crumble to pieces when touched; some are partly sandy, partly calcareous; and the soft substance effervesces with nitric and vitriolic acids. 2. Some shells are evidently crystalline; the valves consist of pure crystal; which in some specimens is like the clearest glass, whilst in others it resembles yellow, green, or smoked glass, &c. 3. The crystalline substance forming the valves is in some cases extremely brittle, but always cleaves in hexagonal cubes. 4. Some of the shells contain innumerable small crystals, besetting their internal surfaces. 5. Some of these strata and shells are exceedingly hard and quite petrified, and can scarcely be separated with a hammer. 6. Others are calcined and decayed, of a muddy, yellow, grey, brown, or red colour, and crumble into dust. 7. And I have observed that between the valves of one shell, a number of small ones were concealed, viz., little bivalves, turbinites, and pectinites, which seemed to have taken refuge in the cavity of the larger shell.

We may conclude from this variety of petrifactions, that a change of things has taken place in the bowels of the earth by the agency of fire and water; and also that the primeval ocean was a hundred ells or more above the present ocean, since we see that, at such an elevation, more than ten strata are formed of nothing but shells. If any one should wish for specimens in proof, he may procure heaps and waggon loads from these strata, and a single piece of stone will afford him nearly all the varieties he desires.

In like manner, there is a very thick stratum of shells at Bahus, near Norway, in a mountain ninety ells, at least, above the level of the sea. These shells are so plentiful, that the inhabitants burn them as affording the best lime, which is sold throughout the whole district: not to mention innumerable other instances.

On the harder Strata, consisting of the common Granite; and their origin.

I was surprised at discovering amongst the strata in several localities, some consisting entirely of granite, of the same kind as that usually found in mountain-chains, such as the Alps and most of the northern mountains, which have been hitherto regarded as contemporaneous in their origin with the earth itself, and as having occupied their present position from the very beginning. Nevertheless, that they were once soft and argillaceous, is evident from strata of the same granite existing in several places. Thus:—1. In West Gothland, in the Billingen mountain, which is three or four miles in length, the upper stratum is pure granite. 2. Beneath this, there are calcareous, scissile, argillaceous and other strata, containing petrifactions of various kinds, as shells, insects, especially marine animalcules. 3. The above stratum of granite is seven or eight ells thick, and divided in two places. 4. There is a horizontal division on the under side, viz., between the granite and the calcareous and scissile stones below, which division appears to have been produced by the action of a watery surface. 5. These stones are as hard as the granite, and will take a polish; they are also of the same colour, and cannot be converted into lime; so that they do not seem to differ in any respect from the common granite of which mountain-chains are composed. 6. The same observation may be repeated in many other mountains in the above province, as in Mösseberg, Hunneberg, and on one side of Kinnekulla, whose summit consists of a very thick crust of granite, with layers of calcareous, scissile, and other kinds of stone beneath it. 7. This granite generally breaks in cubical masses; hence the stratum stands out perpendicularly, and fallen fragments lie scattered at the foot of the mountain. 8. In the province of Bahus, there are mountains of this granite, divided into very thick layers or strata, which, however, lie in an oblique position. 9. Near

Liège, and in other places, I saw a layer of this same hard granitic rock between the argillaceous and scissile strata.

From these observations we may conclude, 1. That the matter of the common granite was once argillaceous, though of a very fine description. 2. That, together with the other strata, it originated at the bottom of the diluvian ocean, as is proved by its also lying in strata, and having calcareous, scissile, and other rocks beneath it, which are occasionally full of marine remains.

But that this primeval or argillaceous matter was finer or more subtle than the other substances, is clearly shewn by the circumstance, that no insects, marine animalcules, or plants are found in it. This view of ours may be elucidated by experience, and is supported by the following experiment. I took some very fine powder, which I had scraped with great care from the hard rock, and mixed it with water in a capacious glass vessel; when I had shaken it up for a long time, I set the vessel aside, to allow the powder to settle gradually. As it was so fine, 1. It subsided very slowly in the water, the process occupying many hours; nevertheless, a sediment was always formed. 2. When the fluid had rested for six hours, and I had reason to think that the powder had subsided into a compact mass, still I found that on slanting the glass, the whole of the thick sediment or mixture obeyed the same direction. 3. I then dropped in a little sand, which passed through the matter to the bottom. 4. When I placed a shaving of wood with great caution at the bottom, it quickly rose to the surface, through the thick matter. 5. In the same way, small fish were able to rise from the bottom to the surface, and could swim as well in the denser as in the thinner substance. 6. So that for many hours the sediment retained a fluid character, although dense and thick. From this experiment, I think we may conclude that the powder from which the granite mountains originated was extremely fine, that it subsided very slowly, and retained its fluidity for a long time; and that consequently hard substances would sink through it, those of a softer and lighter nature, such as wood and plants, would rise to the surface, while marine animalcules and other living creatures would escape out of it, before the stony or argillaceous matter had time to assume too great a consistence.

Afterwards, however, when the powder had rested for two days, it became somewhat more fixed; yet it parted with its fluidity by very slow degrees; for on disturbing the surface of the water, the surface of the powder likewise was set in motion and rendered uneven. Hence again we may conclude, that the inequality of granite mountains is partly owing to the water on their surface fluctuating, or being otherwise agitated and disturbed. To recapitulate; as the surface of this comparatively soft matter would be influenced by the motion of the water, the inequalities on that surface may have been occasioned in the above manner; and it appears therefore that the powder of which granite consisted must have been far more subtle than that of other hard substances.

On inclined Strata, and the causes of their inclination.

On observing the strata in different localities, we perceive, 1. That many of them lie in a horizontal position. 2. Some are inclined at a small angle, others are more oblique, being 10°, 20°, 40°, or even 90° from the horizon, and this obliquity takes place towards the right, as well as towards the left. 3. Some strata run in a circular curve, of which two examples occur near Aix-la-Chapelle; one of them following a convex circular direction, whilst the other assumes the opposite, or concave circular form. 4. Others are in curves of a different kind, as the elliptic, parabolic, &c. 5. And frequently one part of the same layer is less oblique than another; the upper part more inclined than the lower, and *vice versâ.* 6. These oblique inclinations are not directed towards any particular quarter; but sometimes are towards the south, sometimes towards the north, east, &c. 7. The upper strata frequently lie in a horizontal position, whilst the lower are more or less oblique, as I have remarked at Marburg and in other places. 8. Sometimes the strata in the same mountain assume a serpentine direction, that is, in one place they incline towards the east, and in another towards the west; sometimes they rise up and down four or five times in one hill, as is the case under the Castle of Blanckstein, between Dillenburg and Marburg; also near the city of Cassel, there is a circular incurvation in the part where the strata mutually recede from each other, but elsewhere it is not so, &c., &c. In the hope of ascertaining the causes of this arrangement, I performed the following experiment. 1. I shook pulverized clay and water together, and allowed the mixture to repose; whereupon a horizontal stratum was formed at the bottom of the vessel. 2. On pouring in an additional quantity of muddy water, another stratum was formed upon the lower one, and so on, three or four times in succession; as will be mentioned again hereafter. 3. But these strata combined, and gradually settled into a close mass, within a period varying from twenty-four to forty hours. 4. When I placed a stone which sloped on every side at the bottom of the vessel, as at G, Fig. 41, a stratum was formed upon it, which assumed a horizontal direction; the clay, being deposited horizontally at the sides of the stone, did not seem at all influenced by their obliquity. 5. The same result took place on forming additional layers above this stratum. 6. But on leaving them in a state of repose for a whole day, they subsided more and more; the stratum *a* sinking down towards *c*, the latter towards *e*, and so on. 7. When these strata had gradually subsided, and became more closely united, a greater sinking had taken place where there was a greater depth of the soft substance, as on the side *ah*; but above the stone at *mn*, where there was but little matter which could subside, it had not, of course, sunk so much. 8. The wider intervals between the strata may have been produced in this manner. If therefore the mountain ridges, sands and other substances at the bottom were thrown into heaps by the ocean, they would form an uneven surface, and when the strata were deposited upon this foundation, they would be bent into circles, curves and angles more or less acute, according to the inequalities at their base. At least, some kind of subsidence appears very certainly to have taken place, which I am inclined to attribute to the means stated above; but in matters of such antiquity, it is only by conjectures and experiments that we can obtain any insight into their causes.

On the causes of the varieties in Strata.

Great diversity exists in strata composed of the same material. 1. There is a considerable difference in their hardness; thus scissile, resembling clay of the same kind, is sometimes intermediate in hardness between clay and stone, and sometimes it is very hard indeed. 2. They differ greatly in colour also, for we find that strata of the same kind are either grey, brown, yellow, red, blue, green, or black. 3. Strata are sometimes softened into clay, bole, sand, and ochre. 4. Some strata are impregnated with vitriol, alum, nitre, or other salts or minerals. 5. Others are converted into lime, chalk, fossil coal and other substances, which owe their origin entirely to changes that have taken place at periods subsequent to the Deluge; we are confirmed in this view by finding that one stratum differs greatly from another lying close beside it; as a stratum of fossil coal from a neighbouring scissile stratum, &c. The causes of this appear to be as follows: 1. Fluids, as fire, oil, water, &c., will permeate the strata obliquely upwards, and arrive at the surface between their planes of contact. 2. If water, tinged and impregnated with the salt, sulphur, &c., of other strata, filter upwards, the substances through which it passes will be tinged in layers thereby. 3. If a stratum be in an oblique or horizontal position, the fluid penetrates in the direction of its layers: heat also follows the same course, but only upwards; oil or asphaltic matter likewise; water tinged with salt, alum, nitre, vitriol, or other bodies, creeps also along the strata; and any sulphureous or mineral exhalations accompanying the heat or water follow the same course. 4. And wherever the fluid penetrates, it impregnates both the surfaces and the substance of the strata, and consequently occasions changes in their matter, salts, sulphur, hardness, colour, &c. 5. Hence we find that whole strata have undergone a change, whilst others in their immediate vicinity have remained untouched; because the fluid had forced a passage between the planes of contact of its own stratum, and had impregnated the surfaces by infiltration. Thus a vein of fossil coal frequently has a scissile stratum near it, varying in hardness and shade of colour; and a stratum of limestone may lie next to one of clay, sand, &c. 6. This result may be shewn experimentally by dipping the bottom of a scissile stone in oil, and the other part in water; when the oil will be seen penetrating between the layers of the stone, from the bottom upwards; the water also will do the same; as will be clearly shewn in the following pages in our experiments with sponges and spongy substances.

Observations, and points to be observed, concerning Strata, their separation, arrangement, and differences.

That strata of such different kinds originated in a universal diluvian ocean, will not, I apprehend, appear at all doubtful; the following experiment may throw some light on the manner in which the layers were formed in it. 1. I took a sort of pulverized clay, and mixed it with water in a glass vessel, which I afterwards shook repeatedly, so as to mingle the contents thoroughly together, and render the fluid equally turbid throughout. 2. I poured a part of this muddy water into another glass, which I placed aside for several hours, until the clay had subsided to the bottom. 3. I then added another portion of the muddy water, and left it also until its clay was deposited. 4. I then added a third and a fourth portion. 5. And I remarked that the clay had settled down in layers, one stratum above another; and that they appeared distinctly separated from each other, because the subsidence had taken place at different times. 6. On leaving it at rest for a still longer period, the clay became more and more compact, and hardened spontaneously, although the water remained above it. 7. The water being then drained off, and the sediment allowed to dry, (which required the utmost care,) the layers separated from each other spontaneously. Now the same might have taken place at the bottom of the ocean, for as its waters were rendered turbid by the clay, they might, whilst tranquil, have deposited it in a pulverized state at the bottom; other layers might afterwards have been added, which could be distinctly separated, as was the case in the glass vessel. This separation would be promoted by the waters flowing off, for in this case the process of drying would naturally cause the strata to shrink and contract above and below, as far as the central line; thus producing a division into layers, with intermediate spaces, wide in proportion to the thickness of the strata; these intervals were afterwards filled with some other fluid or substance.

Secondly: We have to observe, that no regular order is kept in the strata; that the light substances do not always lie above, nor the heavy below, unless they were deposited at the same period; that is to say, unless the heavier and lighter matters have been mixed together and subsided at the same time. For, 1. On throwing a little sand into the layers of pulverized clay mentioned above, it sank through them to the bottom. 2. But when the clay had acquired a somewhat firmer consistence, and had formed a stratum, the sand no longer passed through, but settled in a layer above it. 3. When clay, fine sand in powder, coarse sand, and iron filings were mixed together and well shaken, the metallic particles first sank to the bottom, then the coarse sand, and afterwards the fine sand mixed with the clay. 4. The same effect was produced by using one sort of matter, but decreasing in bulk, such as coarsely and finely pulverized clay; the larger pieces subsided first, and were followed by the lighter or smaller parts. These experiments lead us to the conclusion, *firstly*, that in those deposits which were formed at the same period, the heavier substances were the first to subside, and afterwards the lighter; or that the larger pieces were the first, and afterwards the smaller. *Secondly*. That if these deposits were formed during a long period, or successively, the lighter matters might occupy the lowest place, and the heavier lie at the top. *Thirdly*. That owing to these causes, there cannot be any certain arrangement of the strata or their particles. I have sometimes observed the scissile above, with sandstone beneath it, and limestone lower still; sometimes the limestone has been uppermost, then came the sandstone, and then the scissile; occasionally the grey or common rock has been placed above the limestone, of which many examples may be seen in Sweden.

For instance, I will mention a few near Helsingborg, in Schonen. There is, 1. An upper stratum of soil or earth. 2. The next is clay. 3. The third is sand. 4. The fourth is a soft scissile of a blue colour, which deliquesces on exposure to the air. 5. The fifth is likewise scissile, but harder and darker coloured. 6. Then comes a vein of fossil coal, one foot thick. 7. The seventh is clay of different sorts and colours, four ells deep. 8. The eighth is soft sandstone. 9. The ninth is a harder kind of sandstone, fit for grindstones; for which purpose it is quarried. 10. The tenth is a grey sandstone, and then a red variety. In other places the arrangement is different, as in Mount Bellingen; where, 1. The surface is covered with a very thick stratum of common grey rock. 2. Then comes a stratum of very hard black limestone, divided into thick layers. 3. Next, argillaceous scissile of various kinds. 4. Then there are different kinds of calcareous stone, red, yellow, and ash coloured. 5. The fifth appears to be formed of a softer description of scissile, which is succeeded by limestone, &c. The arrangement differs again in Kinnekulla and other mountains; so that we may lay down the rule, that where the bottom of the ocean has been stratified at different periods, the strata do not occur in any certain order as determined by their weight. This remark, however, is only applicable to those strata which appear on the crust of the earth.

Thirdly: It is to be observed that all hard stony bodies are formed in strata, excepting those substances which have been produced in stones during long periods. Thus we find, 1. That earths and boles of various sorts and colours, are deposited in layers. 2. Also clays of different kinds and colours. 3. Likewise different sorts of sand, varying in colour and fineness. 4. Sandstones again, varying in kind, colour, and hardness. 5. Scissiles, presenting the same variety. 6. Limestones, the same. 7. Gypsums. 8. Marbles. 9. Silicious and saline bodies. 10. The hardest stones of the common grey kind. 11. Talc stones of different sorts. 12. Stones already calcined, stony marl, chalk, and even strata of true lime. 13. Fossil coal.

As metallic ores are to be classed among vegetable growths, and as they insinuate themselves into the above-mentioned stones during long periods, so they are not found in strata like other hard stony bodies. Nevertheless, we meet with strata containing ores, as of iron, copper, &c.; also boles, clays and sands, rich in metals; there are likewise marcasites, sulphureous stones, aluminous and vitriolic scissiles, and layers of ochre; to say nothing of strata of shells and other marine remains, and of pebbles and mixtures of various materials. We thus have some grounds for concluding that there is no kind of stone, unless its origin be extended over considerable periods of time, but may exist in strata; notwithstanding that the same kind may be found in the mountain-chains, as granite, limestone, sandstone, clay, &c.; which indicates, that primitively all hard bodies originated from clays, salts, and their combinations, and were formed at the bottom of the ocean.

Fourthly: The inter-strata should also be carefully examined; for, 1. They differ greatly from the strata. 2. Sometimes they consist of the substance which lies above the strata, and is carried down with the water. 3. Occasionally they are formed of the matter lying beneath, which is brought up by the water. 4. Hence the inter-strata are found to consist of various substances, boles, red ochres, clays, lime, pebbles, and sands, but not of the same substances as the strata. 5. Sometimes they contain a sulphureous and bituminous substance, or asphaltum. 6. They are likewise impregnated with metallic ores, as iron, copper, and silver; or with vitriolic and aluminous minerals. 7. They occasionally contain the nobler substances, crystals, &c. 8. Also waters of various kinds, which have been impregnated by the surfaces of the layers through which they have passed, and impart their qualities to the surfaces of fresh strata. Almost every change observed in the strata, is produced by the penetration and infiltration of exhalations, spirits, and waters through the interstices; consequently they will well repay our attention, and will help us to very many conclusions respecting the changes that have taken place in both hard and soft bodies since the diluvian period.

Nor are the substances imbedded in the strata less worthy of observation. Thus we have, 1. Plants, shells, animals, &c. 2. It frequently happens, that some of these remains are found entire, some are indurated, whilst others are softened into lime, and others into clay, sand, or bole; others again are converted into flint, stones, crystals, and many other substances. 3. Various hardenings sometimes occur, and different stones result; in one case siliceous material, in another calcareous, at one time bacon stone, at another crystals. 4. Or into still nobler substances, as diamonds, &c. 5. Sometimes the matters contained are fluid, as asphaltum, bitumen, or water. 6. Hence also we have the various kinds of marcasites, minerals, metallic bodies, and some in a native state. 7. To say nothing of artificial and figured stones, which exist in a great variety, as belemnites, ætites, entrochi, as well as grained stones, crystals, &c., &c.

On Stony Marl or Margenstein.

Stony marl is a kind of stone which has been calcined, perhaps by subterranean heat; it is divided into cubical pieces of a soft consistence; it is soluble, and yellow or ashy grey in colour. 1. This stone, whilst entire, and before it is dissolved, effervesces briskly with oil of vitriol and other acids. 2. When pulverized and mixed with diluted oil of vitriol, it effervesces for a long time, and emits a little vapour of an aromatic odour; the glass vessel becomes warm, and the solution afterwards grows clear, almost like water, except that it is pale green; a white feathery sediment is deposited at the bottom, and I remarked that whilst the effervescence lasted, a thin fume passed over the glass. 3. Spirit of nitre causes it to effervesce differently. 4. If the solution in oil of vitriol be diluted with water containing a little syrup of violets, it assumes a beautiful opalescent red tint. 5. The powder is not altered by the spirit of sal ammoniac, but the spirit itself is very speedily absorbed by the stone: nor is it changed by a solution of alum, vitriol, or nitre. 6. It is not soluble in water, although it becomes heavier and somewhat harder. 7. When exposed to the action of heat, it becomes more soluble, spontaneously crumbles to powder, and is calcined: hence it is that houses built of this stone decay the most on the south side.

Fossil coal contains this kind of lime between its layers, as is evident from the following circumstances. 1. A sort of lime is found between the strata of coal, in small bluish-white layers; which, like marl, effervesces powerfully with oil of vitriol and spirit of nitre, and affords nearly the same results as marl in other experiments. 2. If pulverised fossil coal be digested in water for three or four days, the water is very limpid, like this solution of lime. 3. The water in which the coal is digested effervesces a little with oil of vitriol; it grows warm, fumes, and the coal rises to the surface, whilst the lime is precipitated to the bottom. 4. Coal is sometimes found near this lime, as experience testifies, in several places.

On the Circular Crusts found in certain Stones, and on Mountain Nuclei.

In a mountain consisting of different kinds of strata, in the neighbourhood of Liège, near the monastery of the Chartreux, I remarked that, 1. a stratum nearly an ell thick was divided into several lesser strata; it consisted of a hard sandstone, like that used for sharpening scythes and similar instruments, and was everywhere divided into cubic blocks, square and oblong. 2. Each block, when broken, contained circles distinguished by a certain colour, from the surface to the centre. 3. The external surface was brown, the circle next to it was a lighter brown, then came rings of green, and lastly of yellow. 4. These coloured circles were but of little thickness, and the stone between them was almost colourless; but when the material was coarse and soft, the circles were somewhat larger. 5. In the softer stones, these circles were two or three inches apart; but in the hard, they were nearer to each other. 6. In large cubical blocks of the stone, the distance between the circles was nearly in proportion to the size of the stone, so that they were not more numerous in a large than in a small cube. 7. In the hard stones I noticed that the circles were not so far apart, and much more numerous, there being more than ten to be counted in a hard specimen, whilst in a soft piece there were but two or three, and those at a considerable distance from each other. 8. The colour also varied. 9. When the piece was exactly cubical, and every side was a square, as in Fig. 1, the first circle *bbbb* was not exactly round, the next *cccc* was rounder, and the third, *ddd* was exactly spherical. 10. In the oblong pieces shewn in Fig. 2, the first coloured ring *gg* was not exactly elliptical, the next was more so, and the third and fourth *ii* were true ellipses, or ovals. 11. When the blocks of the stratum were of a different shape, the curve also was of a different kind, but always approaching the circular. 12. The cubical blocks I observed in this stratum, were of considerable size, measuring from one-third of an ell to a whole ell on each side. There were other harder strata: one of which was but two inches thick, and had near it many other strata of the same substance; it was divided in the same way into cubical portions, of a square, oblong, or other form; each of these portions could be removed separately; they were of small size, measuring two or three inches across.

In examining this stratum, I observed that, 1. Every piece or block had a nucleus, with circular layers from the circumference to the centre: and as there were myriads of the blocks at hand, I broke a great number to make this observation. 2. The external square crusts or surfaces were hard, and of a ferruginous colour, like well-burnt brick. 3. Within this square or otherwise cubical crust, there was frequently one nucleus of a soft yellow substance like clay or yellow ochre, which crumbled to powder between the fingers. 4. Other pieces contained the same matter, equally soft, but in two nuclei, as in Fig. 3, where the external part is a reddish, but the internal a paler, yellow. 5. In some, the whole cavity contained nothing but a dark bole, which was smooth to the tongue, and seemed to be a species of armenian bole, (see Fig. 4:) but this substance was in small quantity, and only filled a third or a half of the cavity, leaving the rest empty. 6. In others, the outside of the nucleus consisted of a yellow argillaceous material, as in Fig 5, whilst the inside contained this darkish bole, in small quantity. 7. In several, the central part was empty, presenting a mere cavity; round which, however, there was a nucleus of the usual yellow argillaceous matter. 8. In some, the centre contained a harder and almost stony portion, as in Fig. 6, where *m* is nearly of the consistence of stone, with a very small quantity of bole lying around it. In others there was a cavity round this stony part, the outer surface consisting of the yellow substance already mentioned. 9. In all in which there was a cavity, there was a partial roof or arch of yellow substance around the hard portion, as in Fig. 8; where the cavity was in the centre, the soft yellow part extended from the centre or cavity to the inner dotted line: the portion inclosed within the dotted lines was about as hard as a nutshell; the substance beyond this again was soft; hence in some pieces, the outward part was decayed, as in

Fig. 6, and the harder part inside it was larger, and contained a cavity, which sometimes was empty, sometimes full of bole. 10. Thus there were a kind of rudimental ætites, capable of being converted into true and hard ætites by the influence of the sun or the agency of fire. 11. In one specimen, Fig. 7, I counted eight soft layers, of a tawny, brown, and yellow colour; which could be loosened and peeled off by a slight force, but inside them, there was a circular stone of a harder kind. 12. When the pieces were exactly cubical, these nuclei or cavities were exactly round, as in Figs. 3, 4, 5, 6, 7. 13. But when the pieces were oblong, as in Fig. 8, the nuclei were oval, as well as the internal cavity. When the piece was of some other form, as in Fig. 9, the nucleus was neither circular nor elliptical, but exhibited a different curve, although the enclosed matters were circumstanced as in the others.

I also noticed another stratum of the same material, which was divided into pieces, each containing circles as in Figs. 1 and 2, but of a browner and more ferruginous colour; the number of these circles was however the same, but they were hard throughout.

At a little distance, there was a larger stratum, an ell in thickness, composed of the same substance as the nuclei; *i.e.*, of yellow clay or ochre, and equally soft. 1. Above this stratum there was a soft argillaceous scissile stone, spontaneously divided into blocks; and beneath it, an equally thick stratum of hard sandstone, next to which, was a layer of fossil coal. 2. The yellow stony marl or argillaceous ochre of the stratum, although of the same substance as the nuclei, only a little denser, yet presented no cavities or circles, but was homogeneous throughout. 3. I remarked other smaller strata, consisting entirely of this yellow marl. 4. The same kind of material was found in this as in the sand-stone, the same glistening particles of mica, the same coarse pulverization, as though they were of the same stuff, and only differed in hardness and colour. 5. These small strata of yellow marl had a layer of soft argillaceous scissile on each side of them.

I likewise saw, embedded in the same scissile, masses, which when removed were of a most irregular shape, exactly like large stones, and each of which, as far as I could judge from its size, might weigh thirty Swedish naval pounds, or eleven thousand Dutch pounds. 1. Some five of these masses may be seen in this scissile, near the monastery. 2. They consist of the same yellow substance as the strata, or nuclei. 3. They are surrounded on all sides by the soft argillaceous scissile, and are embedded just like stones, without crusts or layers. 4. The same yellow material is observed surrounding belemnites, next to which comes a hard ferruginous matter, which encloses them like a crust, and which is especially seen in those specimens that are procured from the limestone of West Gothland. 5. It also surrounds certain petrifactions. 6. I was informed by my friend, Doctor John Hessel, that this limestone contains pyrites or marcasites, half of which consist of fine bole.

From all these facts, some conclusions may be drawn. Conclusions however cannot be positively true, unless innumerable data have cleared the path and illustrated the traveller, and therefore I only propose the following, in part as subjects for further scrutinizing inquiry; in part as materials for comparison with more numerous data. We conclude then that,

1. Some kind of fluid surrounded the surface of the stone, and penetrated into it, forming the circles described above; but whether this fluid was pure water, or whether it contained alum, vitriol, or lime, or some other substance, there is nothing at present to shew, but the subject must be left for farther enquiry.

2. When water filters in through the sides of a cube, it at last advances with a circular margin.

3. When water passes in through oblong surfaces, it advances with an elliptical border, which becomes more exactly elliptic as it nears the centre; the geometry of which will be spoken of hereafter.

4. Whilst the fluid is penetrating the stone, it stops at a certain distance before passing further, and staining the part where it is, in this way forms the circular divisions.

5. The fluid stops in the centre, and hollows out a cavity by eating away the stone. Hard bodies may be converted into

bole, particularly in the centre, as well as into a kind of yellow ochrey clay or marl.

6. Entire stones, embedded in the argillaceous scissile, seem to be converted into the same substance; and hard bodies may be softened by the reverse process of that by which soft bodies are petrified and hardened.

7. Ætites may be formed in the same way by the corrosion of the hard substances surrounding the stone; and belemnites by the previous corrosion of limestone.

But I was anxious to investigate this substance more fully; and, in the course of experiment, I found that this yellow marl, or argillaceous ochre, was of two kinds, similar, however, in colour and appearance. The first kind, 1. crepitated to a considerable degree in the fire, and split into a thousand pieces with a report like that of a pistol, and therefore did not admit of calcination. 2. I reduced this first kind into fine powder, and poured some acid spirit of nitre upon it; which occasioned a violent ebullition; and a similar result was produced by aqua fortis. 3. It gave out an odour, like that occasioned by dissolving iron in aqua fortis. 4. When the powder was digested for a long time in water, the water separated from it, and remained uncoloured. 5. When the powder was mixed with water, and oil of turpentine added, the oil would not mix with the powder which floated in the water, but was still colourless; nor was the effect different even when the oil was placed first in the glass, and the water poured on afterwards, in which case the latter, together with the powder, passed through the oil, and fell to the bottom; nor would they mingle when the oil of tartar *per deliquium* was added: but when mixed with oil of vitriol, the powder in the water became somewhat milky. 6. The cold infusion of the powder was changed from blue to brownish red by gall-nuts. 7. When the powder was triturated with linseed oil, it became a deep brown; with distilled vinegar, a whitish yellow; with water, the colour of the powder continued unchanged. 8. In other respects, this first kind of marl was comparatively hard, and pale yellow, but when pulverized, it was of an intense reddish yellow.

With respect to the second kind, 1. It was a coarser material and an argillaceous marl, and of a dirty yellow colour. 2. In powder it turned brown with linseed oil; dirty yellow with distilled vinegar; but with water it retained its own colour. It is used as a colouring matter at Liège. 3. It did not crepitate in the fire, but became hard, and preserved its colour, becoming however a little redder. 4. It did not effervesce with nitric acid or aqua fortis, but mixed with them without any manifest action. A third kind, of a dirty colour, and contained in the centre of the stones, was a very fine bole.

From these experiments we may further infer, that the first kind contained a ferruginous element, like the ochre found near acid springs; and that the second kind contained an argillaceous matter.

On the Primeval Matter of the Earth, with reasons for conjecturing that it was water.

Many hypotheses may be stated respecting the primeval matter of the earth and planets; but though nothing but conjecture can be claimed in treating of the remote antiquity of the creation, yet we shall here give reasons which seem to shew that the original matter of the earth may have been water. 1. It does not appear probable that fire was at that period encrusted, since the fire oceans, such as the sun and stars, keep in one place, and cannot be carried with a rapid motion (like that of the earth) in the sphere of their vortex. Then it may be doubted, whether experience can shew a single instance where any pure fire is encrusted, especially with hard* and liquid matter like that of this vast ocean; and whether, in the vortex of a planet formed of encrusted fire, centripetal gravitation would have place. 2. It seems more probable that a primeval, hard chaos, was divided into planets or earths; especially as the Sacred Writings appear to assert the fact. And it seems to be equally and as clearly deducible from them, that the original matter was water. Thus in the first words of the Book of Creation, it is declared that the Spirit moved upon the face of the waters, and separated the waters above the firmament from the waters beneath. Let us suppose then, by way of conjecture, that water was the original matter; and we have the following arguments in confirmation. 1. The rotundity of the earth. For if this universal water first of all formed the earth, rotundity would be produced by the horizontal pressure on the fluid ocean. 2. Had the earth been hard, either in its own nature, or as a fragment of the chaos, it would have been more irregular and angular in its figure than it is. 3. All mountains, and all earthy substances that have been discovered, appear to have been soft originally; which is in some degree rendered clear by the preceding Observations. 4. This is especially the case with the crustal matter, as it seems scarcely possible to deny that the strata therein have had their origin beneath the ocean; also with the harder substances in the bowels of the earth, which are frequently identical with the crustal matter. 5. We are led to the same conjecture by the vast size of the ocean, which still occupies the greater part of the earth's surface. 6. And also, in some measure, by the universal Deluge; for the possibility of water being encrusted with hard matter is more evident than that the same could be the case with fire. And I think it may be shewn theoretically, that after the water was once encrusted, the ocean might again burst forth by the disruption of the crust; especially as the incrustation only takes place on the surface, and by the action of this incrustation, or change of liquids into solids, or of light bodies into heavy, the ocean necessarily subsides. 7. And principally, by the circumstance, that the primeval matter appears to have been elementary and fluid, and to have occupied a position beneath the lighter elements, and glomerated the earth into a sphere; and that in process of time the particles in the very deepest place and under the most enormous pressure appear to have been converted, either by disintegration or combination, into salt, and afterwards into all those bodies which take their origin and constitution from salt; that is to say, into saline mountains, argillaceous, oily, and stony substances of various kinds, &c. But these views are only put forth in the way of conjecture.

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* Water, in the author's theory, consists of *hard* particles: see his chemical *Specimens*, and also his *Principia*.—*(Tr.)*

On the Subsidence of the Seas towards the North.

Experience proves that the seas are subsiding towards the north, and so perceptibly, indeed, that in less than a century, shores which were formerly immersed for a considerable distance are now left bare and dry. For example, 1, there are many towns in Lapland which once possessed convenient harbours, but at present are at a distance of three or four thousand yards from the sea. 2. Some cities in Sweden itself, as Upsal and others, have been separated from the sea coast by an intervening space of several miles, more or less, according to the slope of the surrounding country. 3. I have seen some places in Helsingland, which seventy or eighty years ago were covered by the sea, but now they are dry, and covered with large stones; so that at present the wheel rolls and the hammer resounds where a century ago the waves were heard; and fire and flame are smelting iron where formerly the waters flowed. 4. In various places amongst the mountains, especially in Upland, hooks and fastenings for ships still remain; anchors and timbers of vessels are also found on the hill tops, and in places forty ells above the level of the sea; not to mention the remains of whales and other marine animals. These facts clearly prove that the seas towards the north were formerly very high, but that in process of time they have sunk to their present level.

This subsidence has been placed beyond all doubt, and we may draw the following conclusions from it. 1. All the changes which have occurred in the crust of the earth were not caused by the universal Deluge, but some were occasioned by the sea formerly existing at a height of many furlongs above the present level, whereby certain strata were produced with the petrifactions contained in them; while others however are owing to the great diluvian ocean. 2. The northern countries in particular may have been covered by a deep ocean, whilst those situated more towards the south were left dry. 3. As this ocean appears to have subsided gradually, we shall not be surprised on finding that part of the land which at present is continental may formerly have been insular; for in this subsiding of the sea, the higher parts, as the hills and hill tops, would be the first to emerge, and the rest would be uncovered afterwards. 4. Hence that celebrated writer, the late Olaf Rudbeck, was very probably correct in asserting in his *Atlantis*, that Sweden was by different authors formerly called an island, under the names of Atlantis, Thule, Scania, Mænheim, &c. 5. If it be true, as some maintain, that the seas towards the equator are but little elevated, or retain their horizontal altitude, we might conclude that the pressure of our vortex is unequal, and greater towards the poles than towards the equator; and that the shape of our globe is more circular and round at present than it was formerly. 6. This change must necessarily have occasioned a difference in the dimensions of the degrees of latitude, &c. 7. That the Baltic sea however is above the level of the Northern or German Ocean, is evident from the beds and the descent of those rivers, which almost cut through Sweden from Stockholm to Gottenburg; the highest district is Orebro, whence the rivers run down on each side towards the sea; and on calculating their course and altitude, we find that they have a fall of nearly seventy ells towards the German Ocean, but a much smaller fall towards the Baltic. Hence the subsidence of the latter sea towards the north may have been caused by its flowing into the German Ocean. But this is a subject which I leave to be discussed by others.

Observations and Experiments on the origin, temperature, and saline components of Hot Springs.

I am aware that many scientific enquirers have investigated the nature of thermal or hot springs with the utmost care and attention; nevertheless, without contradicting any of them, I wish to state my own opinion, in doing which I shall only describe such results as have been obtained by observation, without venturing farther than experience will lead me. In order however to understand what follows, we must take notice, that,

I. *Water cannot be in more favourable circumstances for rising above its level, as it were spontaneously, than when it is between thin strata or layers of stones.* To prove this fact by experiment, I took different kinds of scissile stone, divided almost imperceptibly into the thinnest layers, and, 1. I dipped one end of them into water, which after a little time crept up between the layers, and rose spontaneously to the surface or top of the stone. 2. This was shewn still better by dipping the bottom of the layers in oil of turpentine. 3. The water rose still more rapidly when warmed. These results shew that both hot and cold water, and oil, will ascend between layers of stone by a kind of spontaneous effort, without any assistance from pressure. 4. Hence, on examining the strata of scissiles, we see everywhere in their contact that there has been some kind of fluid, either calcareous, aluminous, vitriolic, oleaginous, asphaltic or sulphurous, which had either stained the surfaces of the strata, or had formed an interstratum. To place this point in a clearer light, I subjoin some parallel experiments on the spontaneous ascent of water. 1. If two pieces of marble or glass be laid very closely together, and one end of them be immersed in water or oil, the fluid creeps upwards between the apposed surfaces and arrives at the top: as may be proved by placing bibulous paper between them. 2. The fluid rises rapidly and easily in proportion as the pieces are closely joined. 3. This experiment succeeds as well in a vacuum as in the air; according to that enlightened English authority, Hauksbee. 4. It is a well known fact, that water rises spontaneously in sugar, lime, snow, ashes, sponge, and all spongy bodies with small pores or passages. And in glass tubes, water rises above its external level in proportion as their bore is small; the sap also in plants, trees, branches, leaves, &c., follows the same law; gaining the tops, and moistening all the parts, and giving birth to fresh green foliage and beautiful branches. We may therefore conclude that water rises spontaneously between layers, or through passages of very small dimensions, and is not under these circumstances acted upon by gravity. Here, then, we have the cause of those numerous springs, which gush from the surface of the earth's crust.

This view is strengthened by the immense number of springs that come forth from one strata; to say nothing of those in foreign countries, which have been described to the learned world by different travellers. Thus we often find that, 1. Three or four kinds of springs issue from the same soil, or the same rocky bed. 2. And acidulous springs frequently exist near others of pure water. 3. Also hot springs near cold ones, as at

Aix-la-Chapelle. 4. Vitriolized waters impregnated with aluminous and metallic particles of various sorts, as at Liège, Spa, &c. But let us quit the foreign springs, and mention some in our own country. 5. In a very high mountain in Sweden, the Kinnekulla, a fountain of pure water springs from innumerable fissures in one of the strata. 6. There are similar fountains in Billingen, Hunneberg, Mösseberg, and other mountains in West Gothland, which are stratified to their very bases, and the water is often sufficiently abundant to keep a mill-wheel constantly going: water courses and small lakes are formed likewise on the very tops of the mountains. 7. At Rhyda in West Gothland, three different kinds of springs gush from one bed of soil; two of them are vitriolized in different proportions, and the third, in their immediate vicinity, is a spring of pure water; and all three flow through the clefts and fissures between the layers. Thus we find, both by experiments and from observation, that water rises upwards between the closest joinings of the flat surfaces of the layers, and through channels in mountains which nothing else could penetrate.

II. The second point to be noticed, is, that *fire may commence with a small beginning, and afterwards increase, so as to diffuse itself through bodies of immense size. And if covered up, it may last for centuries.* The diffusion of fire from a small beginning is sufficiently evident, as the greatest conflagration may arise from a single spark. It bursts out spontaneously in stacks of hay and corn. In a large and well-closed iron furnace it is diffused from a little charcoal throughout the whole mass of fuel; likewise through heaps of sulphurous and other stones; as may be seen throughout the mining districts.

That heat, when once kindled, will last for a great length of time in covered places, is shewn by the following circumstances. 1. In large iron furnaces, completely filled with charcoal, a little fire is introduced at the lower part, and the furnace closed up. In due time, the heat gradually spreads throughout the mass of charcoal, and lasts for a fortnight without much consumption of fuel; becoming more intense every day, and seeming as if it might exist for several months, if required. 2. In the furnaces used for making copper into brass, if the apertures be closed, the fire remains in the charcoal for several weeks, without any great consumption of fuel; it is, however, converted into heat; that is to say, the colour of the fire is changed to black. 3. Fire well covered over with dust is placed beneath heaps of copper and other ores; when thus covered, it seems to spread in a circular direction, and will keep alive for six weeks. 4. In burning wood and trees for charcoal, fire is placed beneath them, and the heap is well covered up with dust; but although the fire is thus surrounded, it becomes diffused throughout the pile, and converting the substance of the wood into charcoal, will remain in a state of activity for whole months. 5. The same result takes place if live fire, brands, or pieces of charcoal are covered with ashes. Thus when the episcopal seat of Brunsbo at Skara in Upsal, where my right reverend and excellent father resides, was destroyed by fire, the heat was found to be retained in the charred timbers beneath the ashes for three months. 6. We likewise have instances of mountains of fossil coal and other substances having smoked for long periods after once being heated.

From these examples we may now proceed to consider the subterranean heat which causes the warmth of thermal springs; and we may argue that it will diffuse itself through a whole mountain from a very small beginning; *i.e.* from some commingling of sulphur, vitriol, iron, and water. These substances would prove quite sufficient for this result, especially in stratified mountains, where the diffusion would easily take place, according to the reasoning and experiments already adduced. These arguments also prove, that when heat is once shut up in these mountains, it may remain for centuries without being extinguished; but as soon as an opening is made, it breaks forth in flames.

That there is some sort of subterranean fire, confined however to the crust of the earth, is sufficiently proved by, 1. The existence of volcanoes which vomit flames, as Vesuvius, Ætna, and others. 2. Also of mountains which are occasionally hot and emit hot fumes or vapours. 3. Of others from which the hottest springs gush forth. 4. In many places calcareous stones are found to be converted into true lime, and whole mountains into chalk; strata of calcareous stone with siliceous matter still enclosed in them, scissile stones, shells, &c., are also converted into lime in like manner. These facts render it impossible to deny the existence of a crustal fire sufficient to penetrate whole mountains, especially such as are lamellated or stratified; in which, after they have once been heated, the fire, provided it be shut up, may last for ages without any great consumption of materials.

We may now perceive, 1. How water will rise to the surface between the flat surfaces of the strata. 2. How heat commencing from a small beginning may be dispersed through various substances, especially if they are lamellated. 3. How when it is enclosed in them, it lasts without much diminution, unless it meets with an orifice. 4. And that, near the surface, stones may be converted into lime.

The *thermal heat* is a natural consequence of these facts; for water passing through the strata of hot mountains, will of course come thoroughly heated to the surface. And if a mountain has received its heat as already mentioned, it will preserve it for centuries, since there are no openings for its escape; and the water which passes upwards through the layers or joinings of such a mountain will necessarily be impregnated with its caloric, and produce a thermal heat.

Before we proceed to the qualities of the *thermal salt*, we will give certain experiments performed with the water of Aix-la-Chapelle at Borcet, which is reputed to be lighter than the water in the city. 1. It smells like sulphur mixed with moistened lime. 2. The taste is saline, as of a nitrous substance mixed with common salt. 3. With gall-nuts it turns yellowish green, but when we add spirit of nitre, the colour is greenish yellow, like the topaz, with a beautiful red layer suspended in the middle, and the fluid intensely green above it, but paler beneath. 4. M. Bregmal, who wrote on the waters of Aix-la-Chapelle, says that it turns milky with gall-nuts; but others allege that it turns black; this however was not the case with the water at Borcet, although it was boiling when poured on the gall-nuts. 5. With syrup of violets it becomes of a dirty yellow, which afterwards changes to a dirty green. 6. With alum it becomes milky, which appearance remains when a solution of nitre is added; but it becomes clear on pouring in a few drops of spirit of nitre. The solution of alum mentioned above is not changed by adding vitriol. 7. With sugar of lead it becomes very milky, and is precipitated by adding white vitriol; the precipitate being white, but the supernatant water green. 8. With common vitriol it is at first rendered turbid, afterwards it forms a thick brown sediment which subsides by degrees; in two hours, the mixture separates into five parts; the vitriol yet undissolved lies at the bottom; then comes a yellow fluid, above which is suspended a thick brown mucilage; the fourth part is a limpid green liquid, and the uppermost is a turbid one. After a lapse of ten or twelve hours, both the upper fluids have mingled to form a yellow one; and this result takes place if either the common green vitriol or the white sort be employed, except that with the white vitriol the colour is fainter. 9. No change was produced by the spirit of sal armeniac, spirit of nitre, aqua fortis, spirit of hartshorn, solution of crude tartar, oil of tartar *per deliquium*, solution of red lead in vinegar, borax, gum arabic, ammoniacum, or other kinds of gum, or by the solution of lead in distilled vinegar. 10. With a solution of mercury in spirit of nitre it turned very milky; but with a solution of the same in aqua fortis, it merely became opaline, and though there was a milkiness, it was less than in the former case. 11. With a solution of copper, the green colour changed toward blue; by adding common vitriol, whilst the copper still remained in it, the colour was rendered dusky and turbid; but when the copper was removed, the vitriol, &c., fell to the bottom and turned black, whilst the solution above it became a beautiful green. 12. With sal armeniac no change took place, but by adding white vitriol it turned green. 13. Nor was any alteration produced by red lead dissolved in distilled vinegar; but on adding white vitriol it turned whitish. 14. It was not changed by borax, but on adding white vitriol, it became a pale turbid yellow, and at length the upper part turned a turbid green. 15. With a solution of camphor no change was produced, but on adding white vitriol, two opaque strata were formed, the upper one of which was beautifully opalescent, of a whitish blue, which some hours afterwards became pellucid. 16. It was not changed by gum ammoniacum, but it turned an intense yellow on adding white vitriol: this effect was also produced on adding the vitriol to a solution with gum arabic. 17. With spirit of hartshorn it was not altered, but when aqua fortis was added, it became a beautiful and intense red, and for a long time gave forth small bubbles. 18. It would not mix with oil of linseed, almonds, or turpentine, any better than with common water, but, like water, became milky on adding oil of tartar *per deliquium*.

The sides and bottom of the passages, through which this hot thermal water flowed, were encrusted with a sort of tartar, which could be broken off in fragments. 1. The colour of this tartar was brown, and sometimes yellow, with small red spots or drops. 2. It was nearly as hard as stone. 3. It had no smell, and only a very faint saline taste. 4. It was violently acted upon by spirit of nitre and aqua fortis. 5. Distilled vinegar dissolved it with effervescence, and the solution was somewhat milky. 6. The solution in vinegar turned green with syrup of violets, but very yellow with gall-nuts. 7. When this tartar was dissolved in aqua fortis, it at first gave out fumes, and increased in volume, but afterwards the liquid turned green, its volume being much augmented. The solution in aqua fortis, when mixed with syrup of violets, was of a colour between green and red, and had a bitter sweet taste; after some time, it inclined to a turbid green, and deposited a substance of an opaline colour. 8. When the tartar was reduced to powder in the fire, it became of a grey colour, something like the deposit just alluded to. 9. A green vegetable growth had fixed upon the sides of these warm springs; the juice expressed from which exhibited no effervescence either with acids or alkalis, although with aqua fortis it gave forth a vinous odour.

From these experiments we may in some measure conclude, that the salt of this thermal water is principally calcareous. I performed a similar set of experiments on a solution of the salt of quick-lime; but they differed in this respect, that some kinds of quick-lime do not yield the same results as others; thus some turn milky with gall-nuts, some become yellowish green; whilst others assume an intermediate appearance between the milky and green.

Moreover, the following arguments seem also to prove, that thermal waters contain a calcareous salt. 1. In the neighbourhood of thermal springs, we generally find calcareous mountains; some of them entire, some partly decayed and fallen into dust, and some partly calcined and converted into pure white lime, with flint embedded in it, either in pieces or in layers; whole fields, therefore, are scattered over with flints of different kinds, which were formerly embedded in the lime, but are now left bare. At Aix-la-Chapelle, I have seen even scissiles and layers of shells, and the very fish converted into lime; from which alone we may conclude that there was once a fire that penetrated the mountain, and calcined its superficial matter. 2. Thermal waters exhale sulphur; like quick-lime, when hot and dissolved in acids, as I have repeatedly experienced. 3. They also have the colour and taste of lime water; and tartar itself is calcareous. 4. The salt of these waters is extremely penetrating, and enters the nerves and bones, just like calcareous salt; which is also used in certain sympathetic inks, and effloresces from the surfaces of gates, walls, and the bark of trees. 5. It is well known that lime water possesses the power of softening hard and nervous swellings, almost in the same way as mineral waters; which also affords reason for concluding that a calcareous salt exists in these thermal waters; in others, a salt of a different nature; and in some, no salt at all; according as the water passes through the crevices of a mountain impregnated with a particular kind of salt, or the contrary, and heated by a fire of long continued burning.

MISCELLANEOUS OBSERVATIONS.

PART II.

On Vitrification, and the change of particles into Glass.

THE following points are worthy of notice in the large iron furnace, in which the crude substance or ore of iron is first roasted. 1. When the scoriæ flow out of the furnace, they immediately harden, and scarcely come in contact with the air before they lose their fluidity, preserving however a degree of tenacity for some time afterwards. 2. Wherever the mass is thinnest, and soonest exposed to the air, as at the corners, edges, and similar parts, the scoriæ appear like pure glass, but this is not the case in the thicker parts. Thus the part which first congeals is converted into glass. 3. If a piece of cold iron be put into the furnace (as is frequently done by the workmen to separate the pure part from the impure), and then withdrawn, it will be found to be encrusted with scoriæ; of which those next to the iron will be converted into brilliant, pellucid glass; but those which are farther off will be ferruginous and dusky brown, and not at all transparent. 4. If a heated rod of iron be thrust in, instead of a cold rod, there is no appearance of vitrification around it. 5. When the melted iron is let out of the furnace, it is as white and bright as silver on the edges, or *ears*, as they are called. 6. This silvery colour is usually observed if the sheet of iron be thin, or in all the iron that first cools. 7. If the beds of sand, into which the iron flows, be moistened, (as is common in some places, especially at the furnaces of Helsingland and Oregrund,) the lowest part to the middle of the mass is of this silvery colour, while the upper parts are grey and black. 8. The iron which has this colour is lighter and more brittle than the remainder. 9. We may then conclude that the particles of the scoriæ, and likewise of the iron, are converted into glass when they cool rapidly, whence this silvery appearance seems to be nothing more than the beginning of vitrification; but if the cooling take place gradually, so that the particles can arrange themselves in a different position, no vitrification occurs.

We shall briefly run over those experimental facts which are generally known. Thus, 1. Glass cools with great rapidity; and as soon as it is removed from the fire, it loses the fluid state and becomes tenacious. 2. It is very tenacious when hot, but very brittle when it cools. 3. It is pellucid, on whatever side it is examined. 4. It has about the same specific gravity as stone, and even although made from metal, still is much lighter than metal. 5. There are hardly any bodies but may be converted into glass. 6. Glass, therefore, seems to be the last effect of fire. 7. Glass cannot be reduced to its original principles, except by gold.

These data are sufficient to enable us to explore the nature of glass. Without data, conclusions are of no value. Now if from the above we may define what glass is, and describe the method of its formation, we should say that *vitrification is nothing more than the transposition of particles into bullæ, and the mutual conjunction of the same.* We may infer this from the data. For, 1. We find that substances cannot be converted into glass, except by a very great heat, and unless the particles be thoroughly divided into lesser particles, to admit of being easily transposed by the fire into any given form. 2. Matter becomes lighter when vitrified; which cannot possibly happen unless it swell out into bullæ, in which case the same weight occupies more space, and the bulk is increased, whilst the specific gravity is diminished. 3. Glass is transparent in every direction: which can hardly be accounted for, unless by a certain regularity in the form of the particles; and if this transparency exists on all sides, and the rays of light are transmitted in a similar manner in all directions, I believe that it is scarcely possible to conceive any arrangement of the particles better calculated to produce this effect, than the bullular, which receives the rays from every side, and allows them to escape in a concentrated form. But if the arrangement were angular or prismatic, or altogether irregular, the rays would be broken, and other colours would be produced. 4. Vitrified matters, such as scoriæ, form glass, when cooled quickly, but not otherwise. The heavier particles of iron are in the same case; for sudden cooling prevents the particles from being ranged in any other position than that which they occupied in the fluid state. If, then, they are suddenly cooled by the action of air, water, or very cold iron, or by the thinness of the mass, the particles must preserve the same arrangement as they have when fluid, so as to be comparatively little disturbed from the regular position, and to display the transparency and all the other visible properties of glass. But if, by slow cooling, the particles are confused, and the lighter rise upwards while the heavier sink down, then the bullular and even arrangement is destroyed, and a kind of disorder is occasioned; and hence there is neither transparency nor any other peculiarity of glass, &c.

It appears that the same conclusion may be deduced from the nature of fire, which generally converts the surrounding particles into bullæ. Thus, 1. If there be more fire on the outside of any substance than in the inside, that substance is formed into a globe by the fire. 2. If there be more fire within the substance than on the outside, then the fire forms it into bullæ; as is proved by thousands of experiments, as, 1. By boiling water, which the fire converts into myriads of bubbles or bullæ. 2. And when this water passes into vapour, each particle of the latter is bullular. 3. When the scoriæ are flowing out of the furnace, their surface exhibits an infinite quantity of large bullæ, and all the appearance of great ebullition, caused by the powerful issuing of the fire, which produces visible and considerable bullæ. 4. When any metal, as tin, lead, &c., is calcined and stirred about for a long time, we find that it increases in volume, becomes white, and afterwards red in colour; and what is this but the swelling of the particles into bullæ? And while the bulk becomes greater, the specific gravity becomes less, the colour snowy white, and as the process advances, vitrification takes place, and the same body becomes pellucid and still lighter. 5. Hence also we sometimes see an infinity of bubbles in glass, and hence the inclosure of the same matter in the glass tears, as they are called.

This is still better shewn in those bodies which are most easily acted upon by fire. 1. When tartar, lime, minerals, and other alkaline substances are dissolved by acids, the solution forms an immense number of bubbles, which seem to be occasioned by the escape of the smallest particles enclosed therein. 2. When the fire acts upon light fluids, whose particles easily yield to it, as those of milk, we see that the whole volume swells into bubbles; and a similar result takes place when the same particles are churned into butter. 3. Other fat and also certain fetid liquids afford instances of the same thing. 4. This is still more plainly seen in the ley of which soap is made; it is produced from a lixivium of ashes, with an admixture of fat and common salt, from which the tenacity of the particles arises. 5. When this ley has been stirred over the fire for a long time, we see the whole of it converted into a bullular matter. 6. This substance is pellucid so long as it is warm. 7. It is also very tenacious, for if it be raised up, it falls down in tough pellucid sheets like glass; and if the broad side be uppermost, it forms an exact figure of a bent retort. 8. If a portion of this substance be placed in the cold air, nothing can be seen but an infinite number of bullæ. 9. But some of these bullæ are dissolved, and converted into a red or brown fluid, whilst others remain in their place, and are of a white colour. 10. On stirring this liquid, it crackles, and exhibits a degree of brittleness.

But when there is more fire outside the matter than within it, the matter is, as we have said, compressed into globes. This is seen, 1. When a metal runs drop by drop into the fire, a globule is produced. 2. Drops of glass in the fire also produce globules, such as artificial pearls, spherical lenses for the microscope, &c. 3. A drop of water or of mercury is formed into exactly spherical globules, both in the air and *in vacuo;* but as soon as the fire penetrates into it, so as to be more abundant in the drop than outside it, the latter is immediately expanded into bullæ.

These phenomena and data afford us grounds for thinking that vitrification is only a transposition of particles into thin bullæ; that is to say, into the most regular position, since there can be no arrangement of particles of so exact a form as the bullular and spherical. If now we institute a comparison between vitrification and the liquid mentioned above, we find, 1. That the whole of the liquid can be formed into bullæ. 2. And in this state it is fluid. 3. It is so very tenacious that it forms coherent sheets, and assumes the shape of a retort, when it either falls down, or when a blast is directed upon it from below. 4. If this liquid cools, some of the bullæ fall into their pristine position, in which they exhibit an entirely different colour, as is the case in iron; others remain in the bullular state, but if their arrangement and size be unequal, they become white or silvery in colour, as also does iron. 5. If by a very rapid refrigeration the particles can be kept in the same position, they have all the transparency of glass.

But since these conclusions have been drawn from only a small number of data, we may perhaps be enabled, when our facts become more numerous, to acquire a better knowledge of the forms of these particles; and if any enquirer can elicit them more clearly from other data, we shall consider ourselves greatly obliged by the information.

We will conclude these observations by stating the reason why the scoriæ of iron in particular, whilst they remain in the furnace, and as they are flowing out of it, throw up sparks, in great abundance and with considerable force, to a height of two or three ells. On examining these sparks, they prove to be nothing more than globular particles of iron, which are also frequently seen in the same shape on the surface of the scoriæ. The reason appears to be this; the particles of the scoriæ, or the stony particles, have passed into glass or bullæ; but not those of the iron, which as they sink down through the interstices of the bullæ, tend to impede and obstruct the passages through which the fire is escaping; so that it is no wonder that they are cast out by the power of the fire, or are carried to the surface as globules, and thus are separated from the more expanded and lighter matter.

On the softening of hard Bodies, and on the origin of Ætites, Belemnites, &c.

That soft bodies become hard, and are converted into stone, is a well known and indisputable fact; thus clays, bones, animals, especially those of a marine nature, shell-fish, vegetables, and other substances, have been found in a petrified state. But whether hard bodies soften, and decay like trees, is not as yet so well ascertained; nevertheless, I wish to offer some facts to prove that such is the case. 1. Stones of a large size have been observed inclosed in argillaceous scissile matter, and completely converted into an ochreous clay. That they were once stones was sufficiently apparent both from their external shape, and from the internal arrangement and texture of their particles. Five specimens of the kind may be seen near the monastery of the Chartreux at Liège. 2. At the same place there are whole strata of pebbles, all changed into the same sort of clay. 3. Near the harder strata, there are likewise other entire layers of this soft yellow argillaceous substance, exhibiting the same position of the particles, the same micaceous glitter, the same roughness, texture, &c. 4. In the neighbouring hard strata, which were divided into cubical blocks or pieces, each piece was evidently divided by coloured circles, some by three or even more, and the inner circle was of a yellow tinge, like the above-mentioned substance. 5. In some pieces the central part had already become soft, so that the very beginning of the softening process was sufficiently conspicuous. 6. In the other strata, which are also divided into cubical pieces, but of smaller dimensions, nearly every piece was observed to contain the rudiments of ætites, lying as it were in embryo; the whole of their internal substance was divided and even separated into globes or ovals, easily removeable in layers, and consisting partly of clay, and partly of bole, but the square external crust was hard. There was a considerable difference amongst them. Thus some had an empty space in the centre, which in other specimens was half filled with a yellowish bole; in the centre of others there was a hard substance, with a little scanty and soft bole surrounding it; in others, again, the cavity was full of yellowish bole; but all those in which there was no bole contained soft yellow clay, &c. All these circumstances point to one conclusion, viz., that the hard matter is first divided into circles; that it then begins to soften, commencing at the centre, and proceeding towards the surface. Now I think that the origin of ætites may be deduced form these conditions.

I have likewise been informed, 1. That there are some springs which will soften stones. 2. And that marcasites, with one half bole, and the other half marcasite, are found in large calcareous stones. 3. A hard crust of a ferruginous colour is always observed around belemnites inclosed in limestone, especially in West Gothland, in the same way as around these rudiments of ætites; next to which there is yellow clay or ochre. These circumstances may serve to shew, that the limestone is corroded or eaten away, and that by these means the hollow is enlarged in which the belemnite grows. Hence it may be observed, that, *firstly*, there is some kind of liquid which penetrates into stones, and when it stops, eats away and softens the hard parts, as is proved by the circles. But what is this liquid? whether it be calcareous, aluminous, vitriolic, ARGILLACEOUS, pure or other water, cannot yet be clearly determined. The Hon. Robert Boyle, however, has discovered a fluid that penetrated stones and marble, and completely coloured them.* *Secondly*, these hard substances are converted into sand, clay, or bole; the sand and clay are generally yellow, and the bole is brownish: colouring, therefore, appears to be the first degree of softening; conversion into yellow clay, the second; into bole, the third; and the absorption and emptying the space, the fourth. *Thirdly*, the softening takes place where the fluid stops; as decay or rottenness occurs in trees; it begins first of all at the centre, and also in the layers or circles, whereby they become stained, and the liquid stops around them, and dyes them with circular lines of some colour or other. *Fourthly*, we find that water turns iron to rust; which often takes place in layers, the matter engendered being yellow; which shews that hard substances may soften by the inverse process to that by which soft bodies harden.

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* This fluid communicated a beautiful red colour to marble, without at all injuring its texture or polish. See Boyle's Works, folio; London, 1744. Vol. iv., p. 223.—*Tr.*

Hard stone may also be converted into sand, of which we have an example in the sand-hill of Lousberg, to the north of Aix-la-Chapelle, in which nine layers of shells are visible. 1. In some parts, it has precisely the external appearance of a regular mountain; so that if we judged of it by the surface, we should declare that it consisted of the hardest stone, notwithstanding it is only sand. 2. Cubical blocks lie around, as if fallen down from some stratum of hard rock. 3. The internal structure of these blocks, and the graining of their particles, are the same as in hard limestone. 4. In some places nuclei and pebbles are found, embedded and softened into the same species of sand. 5. Also layers of shells changed into lime. 6. Some parts still remain hard. 7. And in another mountain, to the south of the city, there are strata of sand of all kinds of different colours, yellow, red, grey, white, blue, and black; they are generally parallel to each other, with interstrata, embedded stones, and belemnites converted into sand. It is, therefore, probable that hard substances may be converted into sand by the action of water, and perhaps also of fire, in the same way as some kinds of limestone are reduced to powder by dropping water upon them whilst they are hot.

Hard substances are also found softened into lime. Thus we observe, that, 1. There are chalk mountains, which are nothing more than mountains of calcareous stone changed into lime by the agency of fire. 2. A siliceous substance, of very irregular shape, is often seen in the middle of the pieces of chalk. 3. The strata themselves appear to be entirely converted into lime, with layers of flints passing through the midst of them in parallel rows. 4. Scissile stones also are found changed into lime, as at Aix-la-Chapelle. 5. And shell-fish, nay, entire strata of them. 6. In many places, the lime is in a pulverized state, as at Dahla, Schofde, and other places in West Gothland, where whole tracts consist of very white lime reduced to powder, and when the winds and rains have carried it away, the flints that were embedded in it remain behind. 7. I might also instance entire mountains consisting of *margenstein*, or stony marl, divided into fragments; and which seems to be a sort of lime, and affords another proof that stones may be softened into lime.

In the quarries or pits from which the lapis calaminaris is dug, as at Limburg, Stolberg, and other places, the evidences of a softening process are very clear. Thus, at Stolberg, 1. I remarked strata all around, consisting of pure fragments of calcareous and different other stones, as in the already-mentioned mountain of Lousberg near Aix-la-Chapelle, in which two of the strata consist entirely of pieces of lamellated stones. 2. I have sometimes seen similar strata cemented together by a harder stone, closely resembling the common grey rock; by which also the shells at Aix-la-Chapelle are concreted together. 3. Where the lapis calaminaris is dug, nothing can be seen excepting a brown argillaceous matter in irregular lumps, in which these calamine stones are concealed, and which crumbles down when touched by the finger. 4. The lumps are most irregular in point of shape, appearing corroded, carious, and decayed, like scoriæ with recesses, angles, and cavities in every direction. 5. Some are black, others red, yellow, brown, grey, or white; some are comparatively light, and others heavier; they are all embedded separately in this irregular ground. 6. On examining the side or bottom of the pit, we perceive most evident traces of the softening of the calcareous stones into clay, whilst the mineral constituting the calamine remains unchanged. 7. This is plain enough, not merely from the sides of these quarries, but likewise from the rest of the neighbourhood: but the reason why some parts have been softened, and others have formed calamine, is no less obscure than the manner of the formation of stones into ores, and of different other matters into hard bodies. At a future opportunity I will mention many other circumstances corroborating my views; but enough has been said for the present.

On the entrance of Liquids, as, for example, Water and Fire, into hard Bodies.

That water will penetrate into stones and other hard bodies, is generally known; and the manner in which this takes place, may, I believe, be elucidated by the following observation. If we take square blocks of sandstone from any stratum, we shall see, 1. Certain separate coloured circles at a distance from each other. 2. In the first circle we have a ferruginous or brown hue; in the second the brown is lighter, then we have a green, and at length a muddy yellow; while the centre is of the same colour as the stone itself. 3. If the block of stone be exactly cubical or square, the circles are exactly round; if it be oblong, we have ellipses instead of circles; if it be of any other shape, we find again a different curve. 4. In like manner it has been observed of mountain nuclei, in the preceding remarks, that when the sides are square, the nuclei are round; and that when oblong, the nuclei are oval. 5. If the stony substance be hard, the distance between the circles is less; but when it is soft, like sandstone, this distance becomes greater. 6. An equal number of circles is observed whether the piece of stone be large or small.

To demonstrate from this experiment, that in point of force or quantity water enters into hard bodies in the subduplicate ratio of the distances, 1. Let Fig. 10 represent a square block with a circle formed in it by the entrance of water. Now if we consult geometry as to how a circle can be formed by water passing in through square surfaces, the following will be the calculation. 2. The centre is at *m*; whilst the water is entering, it must of course proceed from the surface *c* to the centre *m*, where it stops; hence the line *cm* may be taken as the whole distance which the water traverses in its passage into the stone. 3. Since the water surrounds this square stone on every side, it enters from all points; thus in a right line from *b* to *p*, and from *r* to *o*; which are equal distances. 4. But when it comes from *b* to *n*, and from *r* to *n*, a meeting takes place in *n*, and hence a doubling or combination of the water. 5. Unless the quantity of water be equal at every point, a circle with such distinct colours cannot possibly be formed; and therefore we have to prove that the waters arriving from *b* and *r* towards *n* are conjointly equal in quantity to the single stream of water from *c* towards *z*. 6. This may be seen if the influx takes place in the subduplicate ratio of the distances. Thus let the stream of water be from *c* towards *m*, where it stops; meanwhile, as it proceeds from *c* through *z* to *m*, it diminishes gradually, that is, inversely, as already stated; so that the proportion would be the same if it passed from *m* to *c* in the square *mz*; in the same way, when it passes from *r* to *o* through an equal distance, the force in *n* is diminished to the degree to which it would be increased in passing from *o* to *n*, or as the square *no*; so also in passing from *b* to *p*, at *n* it is as the square *pn*. 7. Now the two squares *no* and *np* are equal to the square *nm*, which is equal to the square *mz*; and the same result is obtained in every other part. 8. Hence we may conclude, *firstly*, that water passing through square surfaces, forms circles, because its quantity is always equal at the points of meeting; and *secondly*, that the influx diminishes in the subduplicate ratio of the distances or velocities.

In a similar manner we ascertain that fire penetrates into hard bodies in the same or subduplicate ratio. Thus, 1. I selected a sort of calcareous stone, which was very hard, and when pulverized was violently acted upon by acids; it was likewise changed into a beautiful blue by vinegar. As this stone was of a deep black colour, it was exceedingly well adapted for my experiment, and therefore I divided it into square pieces. 2. I placed these pieces in a fire, and allowed them to be calcined, but in different degrees. 3. I then withdrew them from the fire before they were entirely calcined, that I might notice the distances to which the fire had penetrated, and I remarked that one of them had been rendered perfectly white by the heat, but that the calcination had not reached the centre. 4. The nucleus that was still uncalcined, seemed of a blacker colour, and was exactly round; but if the piece of stone was of any other shape than square, the nucleus would assume a different curve. 5. I performed a similar experiment with clays, which became yellow or red by the fire. 6. It is necessary that the fire should at first be gentle, and that the heat should gradually increase, and be equal on every side.

That fire, regarded as a force, penetrates into hard bodies in the subduplicate ratio of the distances, may be further demonstrated from the increase of the quantities of ore placed in the large furnace in which iron is first smelted. On this subject, the following points were noticed. 1. When the furnace was filled with large pieces of charcoal, the ore was at first placed in the middle, over the central line, about once in every hour, or rather from seventeen to twenty times during the twenty-four hours. 2. On the first day, only five loads of ore are thrown in at once, for if the quantity be larger, it is not melted; on the next day, seven loads; on the third, nearly nine; on the fourth, ten; on the fifth, eleven; and so on, until on the fourteenth day the quantity is increased to twenty loads, which is the highest limit. 3. On the first day, the ore is only placed in the middle, or over the central line of the furnace; on the next day, at a little distance from the centre; on the third, at a greater distance; and at length on the sixth or eighth day, up to the very walls, and all around wherever we may choose. 4. If the quantity of ore placed in the furnace be increased too rapidly, as, for instance, to twenty loads within ten days, a loss of fusion is occasioned; for about the fortieth or fiftieth day, a sort of resistance arises in the fusion, so that the ore cannot be well melted, unless the furnace be somewhat cooled. These experiments satisfactorily prove that the great stone wall cannot in less than fourteen days receive the degree of fire answering to that in the charcoal; but by its coldness, it diminishes and tempers the fire which is in the charcoal itself, so that in the first days it cannot melt more than five, seven, nine, ten loads; and so on.

Hence it follows, as a general rule, that *the power of fire in hard bodies increases in the subduplicate ratio of the distances to which it penetrates.* If now the heat in the centre of the furnace on the first day equals five; on the second, seven; on the third, nine; on the fourth, nearly ten; and on the fourteenth, twenty; which are in fact the degrees of fire in the same times, the spaces of time are found to be equal; that is, from the first day to the fourteenth; but the increase of the loads (which takes place in the same proportion as the augmentation of the power of the fire,) is as their squares. For example, the squares of 5, 7, 9, 10, 11, and so on to 20, are 25, 49, 81, 100, 121, and so on to 400; or rather, since the quantity placed in the furnace cannot be so precisely observed, the numbers will be 25, 50, 75, 100, 125, &c., up to 400. The differences between these are equal in equal times, increasing by 25, so that at length on the fourteenth day it amounts to $14 \times 25 = 350$, or in practice to 400. Thus the times are equal when the power of the fire increases in the duplicate ratio. Experience also proves how exactly the nature of fire obeys this rule, for if these proportions be not accurately followed, a loss of fusion is occasioned at a future period.

This rule is of great use, for by it,

1. We can ascertain the power and degrees of fire from the centre to the circumference, in whatever substance it may be employed.

2. Also the times and moments of its penetration into hard bodies, by the ratio of its power.

3. Its power in smelting furnaces, &c., and in the stoves used in houses; and the difference caused when the furnaces are square, round, conical, &c.

4. The power of fire in the melting of metals.

5. Likewise on ores subjected to calcination; during which the fire is observed to penetrate these hard substances, and to form a sort of round nucleus in the middle, as in the calx of copper ore.

6. Likewise on vessels, as of lead, which, if kept full of water, are not melted by the hottest fire. The reason of this is, because the power of fire in hard bodies can only be increased in the subduplicate ratio, and as the water prevents this increase, the lead cannot be melted.

7. In the same way, if a piece of very thin paper be wrapped round the lead, it is not burnt until the heat has thoroughly penetrated into and fused the lead; nor is the paper burnt, if it be filled with moist sand, or any other substance which resists heat.

8. In the same manner we ascertain the influx of water into hard bodies, as stones, which become soft in course of time, and give rise to ætites, and certain figured stones, &c.

9. Also the entrance of water into metals.

10. As well as into ores and calcined stones.

11. And the entrance of mineral and other exhalations into hard bodies, &c.

Observations on Cooling, or on the escape of Fire from hard bodies.

The following facts will shew the wonderful nature of fire, as well as the variety which it exhibits in its escape out of hard bodies; but unless we are acquainted with the texture and arrangement of the particles in hard substances, I scarcely think it possible for us to obtain a correct knowledge of cooling, or of the egress of fire from these bodies, as to its degrees, times and distances. For, 1. As soon as the scoriæ of the crude iron flow out of the furnace, they lose their fluidity, and on the surface their fiery colour also. 2. Glass is affected in a very similar manner; although both these substances retain their heat and tenacity for a long time. 3. A quantity of melted iron flowing from the furnace, became hard on the surface in less than a minute, so as to resist a thrust with a stick; but heat remained within it for twelve hours: this mass was two feet long, one foot broad, and three-fifths of a foot thick. 4. The thinner parts of the scoriæ and iron, such as the corners, thin layers, and dust, grow cool more quickly than seems to correspond to the proportion given in what follows: as may be seen in those particles which are transposed into another position, nearly that of glass. 5. The furnace itself can hardly become cool for thirty or forty days; during which time the heat passes through the wall, which it could not do at first, however intense the fire. 6. The coppery stone called *skearsten*, (which is nothing more than copper ore melted and but little purified, containing a large quantity of sulphur,) keeps its heat for six or eight days, although an equal weight and mass of iron grows cold in less than eighteen hours. 7. A mass of copper itself cools in less time than a mass of this kind of stone. 8. Ignited fossil coal is immediately extinguished in the air, though it preserves its heat; the case is the same with stones, either calcined or while calcining, and with other hard substances. 9. Wood charcoal preserves its fiery heat longer than fossil coal. 10. Wood charcoal, when lighted and covered over, loses its flaming fire only, but not its heat. 11. Softer bodies, when heated and well covered, are not easily extinguished, but keep hot for months and years; as charcoal inclosed in a furnace, or covered over with ashes, and as burning timber under the rubbish in conflagrations. 12. The fire contained in charcoal is not extinguished by the air, but augments and breaks forth into flames. This is seen when the heaps of wood charcoal are opened, for the heat contained in them bursts forth into a blaze; so that heated charcoal possesses a property of becoming ignited by the contact of air, very similar to that of quick-lime in being heated by the contact of water.

These facts shew us that no certain rule of cooling can be laid down, since the fire does not seem to escape from hard bodies in proportion to their compactness, mass, or substance; but according to the particular arrangement of their pores. The following points, however, are worthy of notice: 1. Flame is not a definite degree of heat, enabling us to decide as to the degree of cooling by its going out on the surface; for there may be flame or fiery light with either a small or a great heat; thus light may be present in cold bodies, and a very intense heat in those without flame, far more intense than the most brilliant fire; such, for instance, is the heat kindled by the burning-glass. Hence we may conclude theoretically that luminous fire is the tremulation of the igneous volume, or the undulation of the rays. 2. In the more porous substances, the fire on the outside of the particles escapes more rapidly, while that contained within them escapes more slowly; as in sulphureous bodies, carbonaceous scoriæ, and lamellated substances. 3. Fire gradually diminishes from the periphery towards the centre; *i.e.* in the duplicate ratio of the distances, reciprocally as its entrance into hard bodies; which follows therefrom. 4. Unless this ratio be observed in its efflux, the fire remains in the centre, and in a proportionate degree in the periphery also; hence when fire is closed up, it lives for a very long time; inversely as it enters: for unless the duplicate ratio be observed, it cannot enter with accuracy to the centre, as has already been stated. 5. Bodies of the same material cool according to their bulk and cubic shape. 6. The longer that hard bodies have been exposed to the fire, the less can it be kept in them.

But as rules cannot be laid down with exact precision, owing to the difference of cooling occasioned by the difference of the pores, we can here only remark, *first*, that when heat is enclosed, it is preserved in substances for a long time. *Secondly*. It is preserved longer in a large body than in a small one. If we could discover the nature of fire entering into hard bodies, and escaping from them, we might, I believe, deduce from the knowledge many profitable indications bearing upon the calcination of bodies, as sulphurs, salts, and metals; and upon their fixity or volatility, during calcination; as well as upon the internal texture of their particles.

On the improvement of Stoves in Sweden.

I will describe the stoves in use in Sweden and other northern parts, for they differ in their construction from those of Germany, Holland, France, England, &c., and they maintain the heat on different principles. They are furnished with iron plates, by which the fire-box of the stove is closed, after the wood has been converted into charcoal and ashes, so that the heat emitted by the charcoal enters the apartment and fills it; whereby we are enabled to enjoy the heat of one supply of fuel for ten or twelve hours. This advantage induces me to describe them.

There are various ways of constructing stoves; but to make them as advantageous as possible, the following particulars must be attended to.

1. *The stove must be directed towards the centre of the apartment*, so that the radiation from the middle of the fire-place shall tend thither; if therefore we draw lines from the four corners of the room, they intersect each other in its centre, towards which the stove ought to look, and its rays to pass. For the more space the blaze of the fire occupies, the more heat is produced, and the more comfortable the light and warmth. But this is not the case if the fire looks towards the side of the room, for then the flame or heat is at once intercepted by a wall, and is not diffused so generally as by the central arrangement previously commended.

2. *The less the depth of the fire-place, the better.* The stove

may be either square or round, as in Figs. 11, 12, and 13; but let us first examine Fig. 11. The stove *adehl* is tolerably deep, and we find that the rays from the centre *e* pass by *l* to *q*, and by *a* to *p*, and do not occupy much space in the room. But if the depth be no greater than *acil*, more space may be filled by the rays; and still better, if the depth be less, as from *abkl;* the rays can then be largely diffused around, from *g* to *ls* and to *an*. A shallow fire-place, therefore, is better, and much hotter. By the same reasoning it follows, that from a deep fire-place, the rays at *z* (Fig. 14) are not diffused so much, and neither warm the walls and floor so well, nor present so cheerful a sight. If the fire-place be round, as in Fig. 12, and its depth reach to *e*, this construction will be most cheerless and sad, like what we constantly see in small country houses, in which also the rays do not tend towards the centre of the room. Hence, for the reasons just mentioned, it is better when its depth does not pass beyond *g*. In Holland and other countries, there is no depth, nor are there any sides to the fire-place, but only a back, whereby the fire may be enjoyed on every side. In Westphalia and elsewhere there is no wall at all, but the fire-place is in the middle: this is not the case, however, in Sweden, where the logs of wood are not put in layers, but piled perpendicularly; and there is no occasion to use either coal or turf.

3. *The wider the stoves can be made in front, the better.* Let Fig. 14 represent a fire-place of this form; if it be wide, as *afgm*, it diffuses the rays on all sides, from *z* to *yy;* if it be narrower, as *kcdi*, it scatters the rays less widely, as from *z* to *xx*. The same qualities exist in fire-places of a rounder shape, as in Fig. 15; in proportion as the anterior part is dilated, or the curve wide, or its sides are separated, as *osr*, the fire-place is better and more convenient than it would be narrowed to *psq;* owing to the same cause, since the flame can diffuse its rays more readily, and occupy more space, when the anterior part is wide, than when it is narrow.

4. Likewise, *the higher the stove can be made, the more space can the flame occupy on the ceiling,* and the more heat can penetrate into the walls.

By observing these four rules, 1, that the fire-place be not deep; 2. that its sides be wide; 3. that it be lofty; 4. and be directed towards the centre of the apartment, in the same proportion we shall have the advantage of the blaze, and its rays will occupy a larger space on the floor, walls, and ceiling. Hence we remark, that a room frequently appears dull and cheerless, and we shudder at the sight of the fire-place, without any obvious reason; whilst sometimes, on the other hand, with as little evident reason, it looks most comfortable. The difference generally depends upon the construction of the fire-place. But care must be taken, in following these directions, not to engender the nuisance of smoke.

A new construction of Fire-place.

The following fire-place gives out more heat than that in common use.

Description. 1. Fig. 16 is a stove, D is the fire-place constructed according to the rules given above, and which may be either round or square. 2. It should be built of bricks placed endwise. 3. There must be a cavity within the entire stove, which therefore must be double. 4. *b* is a small opening, about eight inches wide, leading into this internal cavity just mentioned. 5. This cavity has three or four horizontal or perpendicular divisions, as *hi*, *lk*, where it is provided with a projection formed of a single brick, so that the heat may circulate from *b* towards *i* and up to *l*, and thus escape with the smoke into the chimney. 6. It is still better to continue this cavity farther, towards the sides *mn*, *pq*. 7. A draught may be formed by making an opening at *e*, communicating with the external air.

This stove possesses the following advantages:

1. It allows us to enjoy the blaze of the fire. On this account an open stove is considered preferable to a closed one, because the blaze is so cheerful, and the loss of it is not compensated even by the gain of increased heat. 2. Whilst the flames flicker, the heat diffuses itself through the wall or hollow side of the stove, first from without, and then from within, because the fire enters through *b*, and as the heat circulates

through its interior, the wall becomes very hot, and so continues after the fire goes out. 3. When the blazing ceases, the ignited charcoal may be pushed into the cavity through *b*, so that the heat will circulate throughout it, and penetrate the wall. 4. The greater the surface, the greater the heat; in concave spherical shapes, such as these stoves, there is a great extent of surface, because their walls are curved inwards, whereby much superficial extent is obtained in little space, and consequently in these stoves we may enjoy the comfort of a blazing fire, as in an open grate. 5. We can likewise have the advantages of a close stove; as after the flame has ceased, this stove possesses as much heat as a close one. 6. The heat can be maintained within the wall by a small charcoal fire, as may be seen in many places where the stoves are built with thin walls and a great extent of surface, in which the heat is kept up by sticks.

The circulating smoke ought to escape over the iron plate of the fire-place; an additional plate, however, is not required to shut its orifice, but the same plate which closes the fire-place will be sufficient. If it be pushed in a little farther, the other aperture can be closed at the same time, and therefore the same plate can be fitted to both openings by a greater or lesser insertion.

This new construction agrees in many respects with a newly-invented stove which a French writer has cleverly brought forward in a treatise called *Le Mechanique du Feu,* but it differs from it in the following particulars: 1. Our stove has an opening leading into the internal cavity, into which the embers can be thrust; whereby the wall may be heated twice as much as by the mere external contact of the fire. 2. When shut up, the heat radiates more abundantly from the walls. 3. No passage is required for the circulating air to enter, nor any orifice for the hot air to escape; because the fire-boxes in Sweden are generally shut up, as we have already said. 4. And this internal cavity can be extended as much as we please through the walls themselves; and the more this is done, the greater will be the heat.

On Wind or Draught Furnaces.

As wind furnaces are much used in calcining and fusing metals, as well as for domestic purposes, I shall briefly touch upon their construction.

The construction differs, according to the purpose for which the furnace is intended; but it must be observed, that, 1. The wind is attracted by the fire, as may be seen in common fire-places, whilst the fire is burning; we then perceive that there is a current of wind blowing into the flame, which afterwards becomes rarefied, and is carried upwards. 2. We see the same when a fire is lighted in the open air, as in the mines, in which cases we feel the violence of this wind, which comes against the bystanders in its course towards the flames. 3. Many persons have remarked that winds like miniature tempests arise during conflagrations. 4. In rude furnaces built with rough bricks or stones, the wind blows through the holes between the stones, and kindles the fire into flame. 5. If we make a communication between the external atmosphere and the fire-box of a stove, as at *a*, Fig. 17, as soon as the fire is lighted, the wind will rush through this passage and fan or blow the fire, and this wherever the passage enters into the stove. 6. In the furnace represented in Fig. 18, in which *b* is the entrance, and *c* the outlet, a very powerful draught is formed at *b* by only lighting the fire. The common or household stoves with bendings are generally constructed on this plan. 7. The same effect is produced when the furnace is like Fig. 19, in which there is an iron grating at *d*, and *e* is a pipe leading into the chimney, or through the window; and likewise in other iron stoves, which are used in many places, and have bent passages of different shapes. 8. Fig. 20 is an iron tube; there is an opening at *f*, and *g* is a pipe leading into the fire-box; the wind presses into the opening *f*, and drives out the smoke through *g*. The late Royal Plenipotentiary, Palmquist, made use of this contrivance, and took it with him on his travels. 9. When the fire-places are made with cross-bars, and with a space beneath, as in Fig. 21, the wind blows through the apertures underneath the fire, and assists the combustion. This construction may be seen in different places where metals are calcined, heated red, and melted; also where vitriol, alum and common salt are evaporated; and in many other factories. There are many different shapes of these fire-places; but the oblong are most usual. 10. The fire-places are round in the furnaces in which zinc and copper are melted for brass. Thus in Fig. 22, *m* is the bottom, pierced with several holes, *n* is a round cavity, *o* is the door, *q* an empty space for the entrance of the air, which rushes through the conical furnace *p* with a very powerful draught. 11. Fig. 23 is on a similar principle, *m* is a grating, and the fuel is thrown in on two sides; *x* is a vacant place like a cell with two doors; above is a round, square, or other shaped furnace, as may be preferred: the wind at *x* rushed into the fire *s*, and drives it upwards with the blast, as seen in some glass-house furnaces, for example, at Liège. 12. I pass over many other varieties, which differ according to the uses for which they are designed; stoves for household purposes, furnaces for distillation, for metallic works, &c. I have only mentioned the preceding kinds as examples of the construction of wind furnaces, and I now proceed to the rules.

Regarding the *fire* itself, it follows from observation and theory, that, 1. A powerful blast is obtained, in proportion as the fire is large. 2. The greater the space occupied by the same fire, the greater will be the blast; thus if the fire be distributed over a broad bottom, more wind will rush in, and kindle it into flame. Hence the oblong fire-place is better than the square, and the square than the round, *i.e.*, if we wish the draught increased. 3. The more flame the fuel can produce, the greater is the draught, for the flame consumes the wind, and carries it upwards; hence a fresh quantity of air must always be supplied, which cannot happen unless the fuel be converted into flame.

As to the *passages* leading to and from the fire, it follows, that, 1. The draught is better in proportion as these passages are wide: thus if the orifice through which the wind enters, or that through which the rarefied smoke escapes into the atmosphere, be broad, the attraction and circulation of the air will be better and more free. 2. The more perpendicular they are, the better: those passages are the best which run straight to and from the air; for as the flame tends upwards spontaneously, if it cannot escape in a perpendicular direction, it is forced out only by the pressure of the air beneath it. 3. The higher they are, the better; for flame or air rarefied by fire, tends upwards, consequently its mounting will be stronger if the passage is lofty; likewise if the incumbent wind comes from a high altitude. 4. The colder both ends of the passages are kept, the better; for the cold air rushing in, presses better upon the air rarefied by the fire; in like manner, in escaping, if the air be cold, the lighter volumes escape through it more easily, owing to the difference of weight. 5. The freest passages are the best. Thus it is better when the passage for the escape of the smoke, rarefied air, fire and heat, prevents them in no part from passing out freely: the same remark applies to the passage through which the air enters. For instance, the outlet must not be impeded by an opposite wall, by any confinement of the external air, or by the wind pressing upon it, and impeding the escape; in like manner the entrance must not be obstructed by a wall, or by closed doors, lest there should not be a sufficient supply of fresh air, owing to the obstacles with which it meets by the more powerful attraction of other places, whereby a deficiency in the draught must necessarily ensue; as may also be the case from other causes.

This may be illustrated, for example, by the furnace in Fig. 18. The orifice through which the wind must escape is at *z*, and it passes out better as the opening is wider: *mmm* are similarly circumstanced, and the escape of the air is facilitated when the passage *c* is more perpendicular; but if it be horizontal, the rarefied air does not rise spontaneously, but stagnates, or is only whirled about by the impulse. The greater the height of the smoke, the better; and the colder the air, the heavier it is, and the lighter volumes rise through it faster. The outlet *(c)* is likewise greatly influenced by the absence of impediments, by there being no opposing surface, no wind, no stagnant air weighing upon it, &c. The same remarks apply to those passages through which the air has to enter; the draught is better, as they are wider, more perpendicular, higher, cooler, and freer from impediments. But in this place I must be brief. Much explanation is indeed needed, but I shall endeavour to afford it when I treat expressly on different sorts of furnaces, such as the various kinds of household stoves, metallic, smelting, calcining, reverberatory, distilling, chemical and other furnaces.

The causes of Smoke in rooms.

There are various causes why chimneys smoke into rooms; indeed the variety of causes is so great, that they are very difficult to ascertain: as, however, it is important to find them out, I have noticed the following particulars on this subject.

EXTERNAL CAUSES.

1. If the wind presses too much upon the outlet of the fireplace, the smoke will be driven into the apartment. This effect is produced, 1. By certain winds which blow more perpendicularly than others, for example, north winds. 2. If the wind be directed towards the outlet of the chimney by the wall, chimneys, or roof of the neighbouring house, or if it forms an eddy, the smoke is driven down into the apartment; consequently, it will not escape freely unless the outlet be carried above the top of the next house. To obviate these inconveniences, several contrivances have been adopted for the outlets of chimneys; some persons make the openings wide, for the wind to escape readily; others cover the aperture with poles, to protect it on two sides, as in Fig. 24. Others prefer the plan shewn in Fig. 25, and some that in Fig. 26. Some use bent coverings, as in Figs. 27 and 28. Some a sort of framework, like Fig. 29. Others make use of semiconical coverings, with a projecting plate like a wing, which is driven round by the wind. This is represented in Fig. 30, where *a* is the aperture, which is always on the opposite side to that from whence the wind is blowing: some persons change the direction of this cone by a small rope outside the house. Other inventors endeavour to provide a remedy for this annoyance in the interior construction of the chimney itself; 1. By leading the chimney obliquely upwards, or in a zigzag. 2. By enlarging or diminishing it above. 3. By making it describe a circular or spiral curve, like a turbinite, or spiral shell. 4. Lastly, some endeavour to correct the mischief by plates.

INTERNAL CAUSES.

The most general rule for curing the smoke, is, *to provide from some quarter a supply of air, to pass off through the fireplace, and carry the smoke along with it.* If this rule be properly observed, we shall command the chief source of this vexatious annoyance; for unless there be a current of air continually circulating through the fire and carrying off the smoke, there are, if I may use the term, no wings or vehicles to assist the latter in its upward flight. The wind that enters for this purpose, comes

I. *From chinks and crevices in the floor of the apartment.* For it is remarked, that when a fire is lighted, the air blows with considerable force through these crevices. Thus, 1. If they be closed, and there be no aperture elsewhere, the smoke frequently comes into the room. 2. Again, if the parts beneath the floor, through which the wind must enter before it passes through the crevices, be air-tight, the smoke is often forced into the room. 3. If there be any outlet for the air in the ceiling, or if there be a chimney in any adjoining apartment, it may happen that the wind which enters elsewhere through the crannies, will not pass out through the chimney of this fireplace. 4. Likewise when the wind does not press upon the lower parts, where it ought to enter, before it passes up through the crevices in the floor, a defect in the draught is occasioned.

II. *From the crevices of the windows.* If the air does not enter through the floor, it must come through the crevices of the window-sashes, and pass up through the fire, to carry the smoke with it. The smoke, therefore, may come into the room when an opposite state of things prevails; thus, 1. If these crevices be too accurately stopped up, and no others exist elsewhere. 2. If the chimneys in the adjoining rooms attract the wind which enters through the crevices of the windows. 3. If the wind does not press upon these crevices, but acts violently in the opposite direction; this cause, however, is but seldom capable of preventing the air from entering.

III. *From the crevices of the doors.* This is the most common source of the draught; especially when there are two or three doors opening into one room. In Fig. 31, ABC represent three rooms. Let us take the middle room B as an example, and we shall observe, that if the wind enters through the joinings of the door *k*, 1. The smoke may enter, owing to the room A being too well closed either by the door, windows and floor. 2. This mischief is rectified by partially opening a window or door in A. 3. If there be a fire in *a*, it may attract the wind before it arrives at *b*. 4. If the fire-place in *a* be of a better construction than that at *b*, that is, if it be higher, wider, &c., it may consume the whole of the wind before it can enter into *b*, and consequently, as the latter is deprived of its draught, it must smoke. 5. If there be a fire in the fire-place *c*, and especially if it be of a superior construction, and have a powerful draught, it may deprive the fire-place *b* of the necessary supply of air, and cause it to smoke. 6. The case is similar when there are doors in other situations, and we must ascertain in every instance where the air comes from, and whither it goes. When the chimney smokes, then, it is important to discover the cause. Thus we often find that it smokes when an adjoining fire is lighted, and not otherwise; or when a door or window is opened, or shut, in the next room. The cause should therefore be examined at once, in the following way. 1. In the first place, see whether the fault exists in the chimney itself, that is, whether it arises from *external causes*, and if so, remedy it accordingly. If there be no defect in the chimney, and still it continues to smoke, the cause must be *internal*, and must be sought for as such. 2. Try with a candle, or a very light leaf, or with the warm hand, where the air enters the room; whether through the crevices of the floor, windows, or door, or through more than one of these sources; but this examination must be made while the fire is alight, or it will not succeed, because at other times there will be no draught or circulation of air.

Having found the entrance through which the air comes, 1. If it be in the floor, see whether there be not a floor beneath, which may be air-tight, and thus impede the draught. 2. If by the windows, examine whether they shut too closely, or whether the external wind does not prevent the draught. 3. If through the crannies of the doors, see whence the air comes into the next room, whether through the floor, door, or chimney, and then perhaps you may cure the smoking by opening or shutting them, as required.

The best cure for smoke seems to be by forming an aperture near *m*, Fig. 32, or elsewhere in the same horizontal line, and directed towards the inside of the chimney; this aperture should communicate by a tube with the external air in some part on the outside of the house, or under the floor. Then when the fire is lighted, the wind will continually enter through *m*, rise upwards through the chimney, and bear off the smoke with it; and this little orifice might be opened and shut by a small plate. Apertures of this kind are usual, but they are carried partly from the fire, and partly from the bottom of the chimney; the draught, however, will be better if the passage runs from the external air, and enters the front of the chimney.

A new construction of Air-pump, worked by Mercury.

It is well known that the air may be exhausted from glass receivers by a pump; but as I was considering the possibility of finding a more convenient mechanism than that in common use, I hit upon the following plan. In Fig. 33, A is a table, like that in the common air-pump: B is a glass receiver: *c* and *d* are two apertures with a valve fitted into each; the valve *c* allows the air to pass out of the receiver, and the valve *d* lets it off into the atmosphere. A hollow conical vessel E, made of iron, is accurately fixed to the under side of this table, in such manner that its cavity includes both the valvular apertures *c* and *d*. The portion *ff* is of leather; and the outer part *g* of the tube is again of iron, but very thin.

Operation. This machine is worked by pouring mercury through *m* in sufficient quantity to fill *ff* and some part of E. On raising the tube *g*, the mercury rises in E until it reaches the table of the pump, then, on depressing *g* below the level of twenty-eight inches, the mercury in E sinks, and draws off the air with it from the receiver through the valve *c*; on raising the tube *g* again, this portion of air passes out through the valve *d*; and thus the tube is alternately depressed and raised, until the whole of the air is exhausted. Under the table, at *z*, there must likewise be an orifice, opened by a screw, to allow the air to enter when required.

Remarks. 1. The more the tube *g* is depressed, the more is the air attracted. 2. When the air is pumped out, the tube must be lowered down more than twenty-eight inches, because such a height of mercury balances the column of the atmosphere. 3. When the air is readmitted, the tube must be raised up as far as *d*, which is indicated by the escape of a few drops of mercury through that valve. 4. In exhausting the air, be careful that the mercury does not fall below the iron cone E, leaving a vacant space in the leathern part *f*; for should this happen, the leather will be compressed, and the proper exhaustion impeded.

On the Salt Works on parts of the Swedish coast.

It is important to publish any facts that have occurred worthy of observation concerning the extraction of salt from sea water on the Swedish coast, for the following reasons. 1. Because certain persons wished to attempt this operation in the reign of King Charles XII., of glorious memory, who deigned to confer very ample privileges on the undertaking. 2. Also because very many of our countrymen, merchants as well as others, and as I have noticed, even the compilers of the *Acta Vratislaviensia*,* thought that the attempt would never succeed, because they saw that at first it was not successful, and they thought that it never would be. These causes induce me to state all that I know on the subject, especially as it has been my office to visit those parts of our shores which are best calculated for this purpose, and to propose the most eligible for selection. During my journey, I observed as follows.

I. The shores of the Baltic are not well adapted for salt boiling, because the water of this sea is very slightly impregnated with salt, on account of being towards the north, and diluted with the waters of the rivers, so that it scarcely contains a thirtieth part of its weight of salt, and still less at certain periods, as was ascertained by an instrument. Nevertheless, the learned Helwig states, in his *Lithographia Angerburgica,* that salt is extracted from the waters of the Baltic in case of necessity; and in the year 1716, the attempt was made at Carlscrona, and the result ascertained.

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* *Sammlung von Natur und Medicin Geschichten;* Breslau, September, 1717, p. 102; art. Neue Saltz Cocturen.

II. On the shores of the German Ocean no greater success is to be expected, owing again to the small quantity of salt contained in those waters. This is the case, 1. About the straits of Helsingborg, where the water seemed to be too diluted, because it is mingled with that of the Baltic. 2. At Halmstadt, owing to the quantity of fresh water poured forth by the large river there. 3. The attempt was more successful at the city of Warberg, where the water was found to contain one-sixteenth of its weight of salt, especially in an island near the castle, where indeed the boiling of salt was commenced some time ago; besides which, in this place there is a good supply of peat or turf, well adapted for the purpose. 4. From Ondshall, as far as Gottenburg, it was unsuccessful, owing to the number of rivers, and especially that large stream Gotha Elf, which dilute the water too much to allow the salt to be extracted from it with any profit.

III. On the shores of the North Sea, from Gottenburg to Norway, I observed, that, 1. At Marstrand the sea was very salt, and many most convenient localities might be selected there; the boiling of salt had indeed been tried in this place by Count Frölick, but the attempt was unsuccessful, because unprofitable, owing to the high price of wood, charcoal, and turf. 2. But from Uddevalla to Norway, many places seemed highly suitable for the undertaking, and particularly at Gulmarsberg, where, *in the first place,* forests of considerable size yet remain. *Secondly.* An abundant supply of wood can be brought from Wermeland and Norway down numerous rivers which convey the best timber to the saw-mills; and an inferior kind of wood answers for evaporating the salt, such as the fragments and refuse from the mills. *Thirdly.* The quantity of peat in the neighbourhood might almost last for ever. *Fourthly.* The water is very salt, one part of salt being frequently obtained from seven to ten parts of water. *Fifthly.* The water in shore is very deep, sixty or seventy ells, and the saltest water may be taken from the bottom. *Sixthly.* Many salt works have been established there, which are still in use; I counted twenty-seven of them.

IV. Salt boiling is common enough in the islands and places on the coast of the province of Bahus, especially near Stromstadt, in some of the bays and creeks of this sea, and above all, in the islands. Thus, 1. I enumerated twenty-seven pans or works for evaporating salt. 2. Formerly, there were still more. 3. But the number has decreased, partly in consequence of the ownership of the localities passing out of the hands of the country people, and partly because the wood could be sold to greater profit at Gottenburg. 4. In the province of Bahus, no other kind of salt is used either in cookery or in salting fish, than what is boiled on its shores.

V. The method of evaporation is very simple, but unprofitable. They have, 1. An oblong iron vessel, six ells in length, three in width, and about four-ninths of an ell deep. 2. This vessel is placed at a little height from the ground upon stones, so that the logs of wood must be placed close beneath it. 3. There is a chimney at the back part of it, for carrying off the smoke. 4. The water is pumped out of the sea, from a depth of five or six ells. 5. It then passes into a wooden canal, from whence it flows in a continual but small stream into the evaporating pan. 6. In the meantime the water in the pan is in constant agitation, and boils vehemently without intermission for twenty-four hours. 7. Until they have evaporated a large quantity of salt, which is in a crystallized state.

VI. The quantity of salt obtained within twenty-four hours, by the labour of one man, and the combustion of a pile of wood measuring three ells square, amounts to one ton, or four tons according to the Dutch measure. 2. The country people sell one such ton for a Dutch florin and a quarter. 3. Hence, no other kind of salt but the domestic is used in the whole district. 4. And it is astonishing that not one person in a thousand in this kingdom is acquainted with the fact.

VII. *Its quality*. 1. Its colour is snow white. 2. It is minutely granulated, like the Luneberg salt. Where the sea is not so salt, its colour inclines to brown. 3. It is used in that province for seasoning food, and for curing flesh, fish, &c., exactly like the foreign salt; the inhabitants esteem it for these purposes, but the people in the neighbouring parts consider it as inferior. 4. It is, however, less fixed, and more soluble in water than the foreign salt.

VIII. *Defects in the process.* This method of boiling salt is faulty in the following points. 1. A very small pan is used, where one double or treble the size might be heated with the same cost of fuel. 2. The long and violent boiling greatly weakens the product, and deprives it of both its saltness and fixity. 3. No time is allowed for the salt to crystallize, consequently the granulation is small. 4. The skimmings are never removed; whereby its fixity is impaired. 5. It is not mixed with any foreign salt, such as the Spanish, or with any acid or other matter, which might assist its crystallization or fixity. 6. The water is not reduced and strengthened by the action of the sun, or of frost, wind, agitation, or motion, before the evaporation is commenced. 7. Nor is it pumped up from the deeper parts of the sea, and consequently it is lighter, and contains less salt.

IX. *Correction of defects.* These defects might be obviated, 1. If larger and more numerous vessels were used, as in Holland, Scotland, and Germany; whereby a smaller quantity of wood produces a larger quantity of salt within the same time. 2. It would be well to make the brine stronger by the action of the sun or by constant agitation, previous to being evaporated. 3. The brine can also be concentrated by freezing, for the pure water is converted into ice, but not the salt water: the celebrated professor, Doctor Roberg,[*] has treated upon this subject in my *Dædalus Hyperboreus.* 4. The salt becomes firmer, more fixed, and altogether better by an admixture of some other kind of salt, such as the French, darker Portuguese, or Scotch, as is practised in Zealand, Dort, and other places, where the darker salts are freed from their impurities by fresh boiling; and a considerable increase both in weight and profit is obtained. This increase of weight may be owing in some degree to a larger quantity of pure water in the crystals; hence, although these renovated salts are whiter, they are also weaker and more watery, as proved by dephlegmation and distillation; on which subjects, the reader is referred to my *Principles*.* 5. They are improved by adding a small portion of acid, and likewise by removing the scum. 6. And especially, by a proper method of boiling and crystallizing, which will be mentioned immediately.

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[*] Professorens Doct. L. Roberg, *tanckar om Salts tilwerkande i Nordlånderne.* Dædalus Hyperboreus, Upsala, 1716, page 28.

From these facts it appears, 1. That the sea water of the province of Bahus is very salt, and may be evaporated for salt to great advantage. 2. In many places, circumstances are very favourable for the undertaking, and there is an inexhaustible supply of peat in those localities where wood is scarce. 3. By the help of art, and of proper boiling, good and fixed salt may be obtained, and in larger quantity, by employing different vessels and processes to those in common use, as mentioned above.

The reasons why this most important work has hitherto been unsuccessful, are, 1. Because at the time when it was attempted, the sea was infested by the hostile Danish fleet, and all the shores and bays were insecure. 2. It was afterwards neglected, because its noble originator, Christopher Polheim, was obliged to proceed to distant parts; and also, because the mercantile inhabitants prefer importing articles of this nature from a distance, to seeing any treasures the produce of their own shores. 3. We have therefore just grounds for believing that this work would be crowned with success, if it were carried on in a proper manner, and especially if the darker salts were purified at the same time, as is practised in Holland.

The method of purifying salts by repeated boiling. I shall here subjoin the method of purifying the darker and impurer salts, as employed in Zealand, Dort, and other places, with considerable profit. The French, impure Spanish, or Scotch salt, is purified in the following manner. 1. The water is brought in ships from the salter parts of the sea, and frequently from considerable distances, as for instance, from the sea to Dort; this sea water contains five *loths*.† 2. The impurer salt is dissolved in this water until it becomes impregnated with thirty-nine *loths*; which is ascertained by a piece of amber floating on the surface. 3. This solution is then pumped into a very capacious round vessel, twenty-seven feet in diameter by three-quarters of a foot in depth, placed over a brick furnace of the same shape, but two ells high. 4. It is here evaporated with a brisk fire, and then skimmed. 5. The salt is left in this vessel to be crystallized by a gentle heat: the crystallization begins on the surface in granules like stars, which concrete together into a thin film, and then sink to the bottom. This continues until everything of a saline nature, as far as possible, has been deposited, and the whole operation is brought to an end within four days. 6. By these means a purified salt is obtained, very white in colour, and in largish grains; whilst its weight has increased from 2 to 3, and its value from 14 to 17. 7. The quantity obtained within these four days amounts to about twenty tons, with about two tons and a half from the sea water, which had been brought to the works; and the whole operation only required as much peat as would cost four-fifths of a Dutch florin in Holland.

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* *Some Specimens of a Work on the Principles of Chemistry, with other Treatises.*

† The loth is nearly equal to half an ounce English.

There are many far more convenient places on the shores of the province of Bahus for purifying the impurer salts than in Holland, for, 1. The sea which washes the coast is so very salt, that it is unnecessary to bring salt water by ship from a distance. 2. Where wood is scarce, peat may be had in great abundance, and at a low price. 3. The iron required for the works is likewise cheap. 4. Besides, the workmen are accustomed to the business. Thus there will not only be the advantage afforded by the facilities and convenience of a port and a salt sea, but also a profit from the increase and purification of the salt.

A Method of ascertaining, by means of a Triangle, the individual Weights of mixed Metals, from the weight of the mass previously ascertained in Water and in Air.

The first method. Have in readiness weights, adapted for scales, of every metal and semi-metal; it will be sufficient to have weights of each metal answering to one, two, four, and eight loths, with one loth-weight divided into grains or smaller parts. 2. Let us suppose that the alloy to be examined consists of copper and tin, as in cannon-metal, bell-metal, &c., and that we wish to ascertain the quantity of the tin. 3. Take such weights of copper and also of tin, (which weights should be ready, as we said above,) as to have three equal weights, namely, of the copper, the tin, and the alloy. Weigh each of these three in water; and first the tin; and observe how many loths and grains it weighs in the water: then take a corresponding number of divisions on a scale, and place them in a given line from *a* to *b*, Fig. 34. Then weigh the mass or mixed metal, and see how many loths and grains it weighs in the water, take as many divisions on the scale, and place them on the same line from *a* to *c*; then weigh the copper in the same way, and mark its weight from *a* to *d*. Take the weight of the mass in air, and a corresponding number of divisions on the scale, and place them on a perpendicular from *d* to *n*. 4. Next, erect a perpendicular from the point *c* to *k*, and from *k* to *m*, which may be done easily by parallels. Then, 5, *md* is the quantity of copper, and *mn* of tin. 6. On taking these lines with a pair of compasses, and measuring them on the scale, the divisions will shew how many loths and grains of copper and tin separately the mass contains.

The second method. If the weights of every sort of metal be not in readiness, it is of no importance, provided the weight of the alloyed mass be known; we will suppose, for example, that it is nine loths. As the specific weight of the metals is known, that of tin being to water as 7·3 to 1, we obtain 7·3 : 6·3::9 : 7·767, that of copper being to water as 8·8 to 1, whence we have 8·8 : 7·8::9 : 7·977. 3. Place these two quantities as before in the same line from *a* to *b*, and from *a* to *d*. 4. Put the mass in water, and observe how much it weighs; and place it in the same line from *a* to *c*. 5. Then proceed as before, to place the lines of the mass *ac* from *d* to *n*, and erect perpendiculars as before; the quantity of copper will be shewn by *md*, and that of the tin by *mn*.

Demonstration. Let the weight of the copper in air$=a$, and in water$=b$. Let the weight of the tin in air$=c$, and in water$=d$; and that of the alloyed mass in air$=e$, and in water $=f$. All these data may be obtained, either by calculation and observation, or by weighing. Now let the weight of the copper in the mass$=x$; then the weight of the tin therein will$=e-x$. To ascertain by calculation how much this mass ought to weigh in water, we proceed as follows. Since the weight of the copper in air$=a$, therefore $a : b :: x : \frac{xb}{a}=$the weight of the copper in the mass whilst in the water; in the same way, $c : d :: e-x : \frac{de-dx}{c}=$that of the tin contained in the mass whilst in water, and their sum$=\frac{xb}{a}+\frac{de-dx}{c}=\frac{cxb+ade-adx}{ac}$. This sum must $=f$; consequently $f=\frac{cxb+ade-adx}{ac}$, or $\frac{acf-ade}{cb-ad}=x$, for the weight of the copper in the mass; and $e-\frac{acf-ade}{cb-ad}=\frac{ecb-ead-acf+ade}{cb-ad}$ gives us that of the tin; whence a proportion may be established between $\frac{acf-ade}{cb-ad}\div\frac{ecb-ead-acf+ade}{cb-ad}$, it becomes $\frac{a}{c}\div\frac{eb-af}{cf-de}$. Now the weights of the copper, tin and mass are equal, that is, $a=c=e$, according to the former proposition; hence e may be substituted for a and c, therefore instead of $\frac{a}{c}\div\frac{eb-af}{cf-de}$, it will be $1\div\frac{b-f}{f-d}$; but the line bc in the figure$=f-d$, and the line $dc=b-f$. Since now the ratio of the copper and tin is as the difference bc to the difference cd, and the side nd is equal to the weight of the mass, and since we obtain the ratio md to nm as bc to cd, hence md and mn will give the weights in air of the copper and tin respectively.

The Glass of Archimedes; an instrument for ascertaining the proportions of mixed metals mechanically, without any calculation.

I have called this instrument the Glass of Archimedes, because we are indebted to that geometrician for the invention for weighing metals and recognizing mixtures by the increase of the volumes. This method was discovered in the case of a crown of gold; but as it requires calculation likewise, I have contrived a glass by which the result may be obtained without any calculation.

Method of preparing the instrument. 1. Make a glass vessel like AM, Fig. 35, having a large cavity in A, and a tube of equal diameter throughout from A to M. 2. Fill the cavity A with water, wine, or any coloured fluid, as far as *pp*. 3. Take some loths of a metal, for instance, four loths of tin, and introduce it through M into A, and observe to what height the water rises in the tube; in this instance we will assume that it rises to *k*. 4. Divide the side *kp* into four equal parts, *ki*, *ih*, *hr*, *rp*, each of which denotes one loth. 5. Proceed in the same way with some other metal, for example, with four loths of copper, and observe again the point to which the fluid rises, which we will suppose to be *d*. Divide the side *dp* into four equal parts, each of which also denotes a loth: we have thus obtained the ascent of the volume of water for four loths of tin, and for four loths of copper. 6. Connect these divisions by the transverse lines, *ar*, *bh*, *ci*, *dk*. 7. Divide *ar* into four equal and parallel parts, *bh* into eight, *ci* into twelve, and *dk* into sixteen; that is, divide each part into as many drachms as are contained in the loths. The glass is now ready for use.

Method of using the instrument. Let us suppose that we have to examine an alloy consisting of copper and tin. 1. Let a certain quantity of it—for example, one, two, three, or four loths, as preferred—be weighed in the air; let us select two loths. 2. Fill the glass with water to *pp*, as directed above. 3. Introduce the alloy, and note how high the water rises, that is, to what division between *b* and *h*. 4. If the metal under examination were pure copper, the water would ascend to *b*; if pure tin, it would ascend to *h*, but as it is an alloy of both, the fluid rises to *z*. 5. The number of lines above this point shews at once how many drachms of copper the mass contains; and those beneath it, the drachms of tin. 5. For example, if the fluid rise to *b*, the mass is pure copper, and has eight drachms above it, up to *h*, which are equivalent to two loths. If it rise to *h*, the metal is pure tin, and weighs eight drachms, being the number of the divisions beneath it, or two loths. If the water ascend to the third intermediate division, the metallic mass contains three drachms of tin, which are beneath, and five of copper, which are above the line. Or if it ascend to the sixth division above *br*, the mass then contains six drachms, or a loth and a half of tin, and two drachms or half a loth of copper.

In like manner if there be three, four or five loths, there are always as many divisions below, as there are drachms of the lighter metal, and as many divisions above, as there are drachms of the heavier metal.

If a larger instrument be required, as for pounds, make the space A more capacious, and the tube AM wider. Take four or eight pounds of metals, and try how high the water rises with copper, iron, silver, lead, &c., and divide this height into as many parts. 2. Join the divisions by transverse lines, and divide the first space into four equal and parallel parts, the second into eight, the third into twelve, and so on, as already described; each of these divisions will indicate four ounces. 3. Or if the first space be divided into eight, the second into sixteen, the third into twenty-four, the fourth into thirty-two, and so on, each division will then denote two ounces.

This method of weighing metals is preferable to that of weighing them in water and in air, according to the Archimedean principle of the increase of volumes; for the following reasons. 1. Because in our method it is of no consequence whether the water be heavy or light. 2. Whether it be well or river water, spirit of wine or oil, red or transparent. 3. But in the other way, it is necessary to know the weight of the water, otherwise a great difference arises from the difference of waters, seasons, heat, locality, climate, &c., which render the experiments somewhat uncertain. 4. It is best when the fluid is red, as it is seen more easily. 5. The interior of the tube should be rubbed with a little oil, to prevent the fluid from rising, as it generally does, to a greater height at the sides than in the middle.

Reasons shewing the impossibility of transmuting Metals, especially into Gold.

The idea of the possibility of transmuting metals, into gold especially, is deeply seated in many minds. The hope of effecting this conversion is encouraged by numerous stories and anecdotes, and by a flood of alchemistic writers, who having for long lost their time and pains, but perhaps found something which in their imagination was a kind of philosopher's stone, wished to teach others, by the darkest enigmas, to travel over the same road, and to allure them onwards, until they too, like their masters before them, had wasted their substance. This being the case, and as the extreme grossness of our vision prevents us from seeing more than the merest surface of gold, so we ought rather to determine the possibility or impossibility of transmutation by reason and experiment, than by ocular demonstration. In this course the following arguments occur to us.

I. Every metal has particles of its own of a peculiar form; silver has its own particles; lead and iron also; as proved by the phenomena of crystallization. Thus silver crystallizes in one way, iron in another, lead in a third. Every metal forms crystals corresponding to the shape of its particles. This is also proved by the very different tastes of different metallic solutions. The solution of one metal is austere; that of another is sweet; a third is exceedingly nauseous, of which mercury is an example; a fourth is very bitter, like silver. This variety of taste must surely result from the form of the particle, which, in proportion as it is pointed, impresses a varying sensation on the papillæ of the tongue. The same conclusion may be drawn from the diversity which occurs in the fusion of metals; from the diversity of their colour, compactness, and other properties; all of which demonstrate that the forms of their particles are very diverse. What therefore can be more beyond natural human power, than by means of some very subtle matter, actually to destroy the forms and intimate constitution of these metallic particles, and to transmute them into new forms, such as those of gold! for example, utterly to destroy the forms of the particles of mercury, to imprint upon them other forms, and thus as it were to create gold anew by the mutation of particles. No one, indeed, will deny, that the particles of gold have their own peculiar form, which is more exact than that of any other metal. This is satisfactorily proved by experiments; for no metal preserves its own identity better, or is more self-similar, in all respects, in fire, in solution, in tenacity, in durability, &c., than gold; which shews that one particle is like another.

II. Another argument is that the individual particles of no metal are larger than those of gold, and consequently none are heavier. First, that no metal has heavier particles than gold, is manifest, 1. From the solution of gold by aqua regia; for gold cannot be dissolved by spirit of nitre or aqua fortis, unless sal armeniac or common salt be added to it: hence it is evident, that larger particles are required to effect the solution of gold than of any other metal; and consequently that the interstices and globes or particles of gold are relatively large. 2. This is also shewn by the experiment of compelling particles of hot water by hammering to pass through a golden vessel, that is, through the pores of the gold: the water at first passes through like sweat, and afterwards in streamlets; proving that the very interstices of the gold are larger than the bodies of the particles of water which pass through them. Thus the diameter of the particle of gold must be seven, if not ten, times larger than that of the particle of water. 3. We may arrive at the same conclusion from the great facility with which mercury penetrates a mass of gold, in such abundance as to change its colour to a snowy white, and with a little heat, to dissolve the gold away. 4. And likewise in some measure from the ease with which gold is melted, which may be owing to a particular cohesion. Therefore, since the interstices of the particles of gold are larger than those of any other metal, it follows geometrically that each of its particles is larger than the particle of any other metal. Hence the particle of gold, which is divisible by the action of fire or of a menstruum, is larger than the particle of any other metal, as proved from the size of the pores. How then is this form to be produced? What will enlarge the body of any particle, and imprint upon it the form of gold? Must not this be effected by filling the interstices?

III. Although the interstices between the particles of gold are so large, yet the weight of the mass far exceeds that of other metals. Each particle therefore must necessarily contain more matter, a greater quantity of the subtlest particles; that is to say, more substance to produce weight. The interstices are ample, but as they cannot increase the weight, the whole of it must be caused by the particle itself, in which there must be more matter than in the particle of any other metal. To transmute silver into gold, twice or even three times the weight would be required; and the same with lead. How then are we to obtain a matter so exceedingly subtle as to insinuate itself into each particle, and treble its weight? If we attempt this by menstrua, it is well known that gold cannot be dissolved by spirit of nitre, nor by aqua fortis, but by the larger particles of common salt, in which case the division is only into the large particles, as may be ascertained in a thousand ways. Still less has fire the power of volatilizing the particles of gold, for it scarcely divides them as effectually as the menstruum. Notwithstanding this, the herd of alchemists, by means of fire, would intrude into the particle of lead or mercury that most subtle matter, that cannot within myriads of degrees be dissolved by any sublunary fire: and still they think that the purpose can be effected by less than a farthing's-worth of pitch.

To these reasons we may add, 1. That as yet no transmutation into the less noble metals has been performed; how then can we expect to make gold, the noblest, heaviest, and most difficult of all? *O auri sacra fames!* 2. Mercury cannot be fixed by any other metal, but by sublimation it flies away in the quantity in which it was added.

We therefore conclude that art can achieve everything with metals, except to change the form and weight of their particles. As regards colour, it can be obtained by an admixture of other particles, or by the change of position produced by the action of fire or solution: for colour is nothing more than the determinate passage of rays through the particles, which if so arranged as to bend the rays entirely, at length produce a colour, either of golden, green, silver, or some other kind; and this, with a thousand varieties. In like manner, ductility and tenacity may no doubt be obtained in almost every substance by means of other particles; because those qualities depend upon the cohesion of the particles of matter. But to produce any change in weight and shape must be considered at the present, as in all past time, as an impossibility.

But it appears worthy of our pains to cultivate the art of separating metals with great exactness; of separating silver from copper, and gold from both, and other noble metals from dross, dirt, sand, and stones. And as it is certain that gold often lies in the bosom of copper, silver, clay, bole, and river sand, so art is required to separate it, which art is really noble and the true alchemy.

The Blood circulates through the Capillaries more easily than through the Trunks of the Arteries.

At first sight, it would perhaps appear, that the blood must circulate with greater difficulty through the minutest arterial ramifications, than through the large branches and trunks; for friction, and the various directions of the parietes of the vessels would seem to present more obstacles in the one case than in the other. It is well known that the course of the blood is from a wide trunk into narrower channels, which ramify into small arteries of imperceptible fineness, through which it at length passes into the veins, and back from the small vessels into the large, returning in a circle to the point from whence it started.

However, if we appeal to experience, we shall find that the blood will flow with much greater facility through such minute pores and tubes as the arterial ramifications, than through the larger and wider channels.

1. In trees and shrubs, which burst forth into new life every spring, we see that the nutritious sap rises by a spontaneous motion from the root to the summit: the tops of the loftiest trees are supplied with a larger quantity of moisture than the lower parts; thus the sap ascends of its own accord through the minutest tubes in the bark, and emulates the circulation of the blood in living beings. 2. If we fill a glass tube with ashes or any dry powder, which has minute passages between its particles, and if we dip the lower end into water,

we shall find within a short time that the water creeps upwards, and gradually moistens the ashes to the top. 3. A similar result takes place in glass tubes of very small bore; if the lower end of these be placed in any red or other liquid, it rises into them above the outside level, and to a greater height, in proportion as the diameter of the tube is less. This experiment succeeds as well in a vacuum as in the air. 4. Likewise if two pieces of polished marble, glass, or other substance are applied to each other, but with a sheet of blotting paper between them, and if the lower end of the pieces be immersed in water, the latter will be carried upwards between the plane surfaces and through the paper, nor will it stop until it arrives at the top: and the narrower the interval between the surfaces, the more speedily does this take place. This experiment succeeds as well with oil or spirit of wine as with water; as well in *vacuo* as in the air. 5. The same result is produced between the thinnest layers of scissile stones. 6. More clearly still in certain spongio-saline bodies, as sugar, different salts, snow, and calcined stones. 7. If a capacious glass vessel be half filled with brine, or a solution of common salt, and set aside to rest, the upper sides of the glass vessel up to the very rim will be gradually encrusted; so also, on pouring water into a moistened glass, some of the water ascends round the sides, which is especially seen if the fluid be coloured. 8. Again, this is still more evident in sponges, in which the water is carried upward spontaneously, and even better if the spongy substance be previously moistened; when the water will rise on the slightest contact with the sponge, and cause it to swell. 9. So also mercury enters into metals. 10. It follows, that water enclosed in a narrow glass tube will neither fall nor rise, but will remain passive.

From these facts it is manifest, that the blood circulates with greater facility through the ramifications of the arteries than through the wide trunks. In the spleen, in the lungs, and in certain membranes, we see nothing but the finest and most delicate arterial ramifications, together with a kind of spongy substance; and when the blood or lymph of the body enters them, it runs from one end to the other, as through a moistened sponge; *i.e.*, it runs from the arteries into the veins spontaneously and passively, without any reaction or weight of its own, which is not the case with the blood in the trunks. Thus experience shews, that the circulation of the blood is performed more easily in the small than in the large arteries.

This is not the place to state the reason why fluids ascend spontaneously through fine pores. We may, however, observe that this effect seems to arise from the minuteness of the particles of water, which can creep up the sides in layers of such thinness, that they (the particles) cannot be disturbed by the air, or the subtler matter. Hence we see, 1. That water generally creeps upwards along the surfaces of glass. 2. When the fluid contained in a glass vessel is bounded by its edges, it is observed to stand higher there, and to rise obliquely up to them. 3. From the edges it slopes down towards the centre, and hence the froth tends to the middle of the liquor. 4. This is still more evident in the finer pores or passages, where water gradually creeps round the surfaces, and no column of air or ether can dislodge it: whence it may be demonstrated geometrically, that the fluid is driven upwards rather than downwards by such an oblique pressure. But these matters will be discussed elsewhere.

MISCELLANEOUS OBSERVATIONS.

PART III.

On a new germination of pure Water when converted into Ice.

The industrious ingenuity of man has discovered several methods of forming artificial trees and shrubs, of gold, silver, mercury, lead, tin, iron, &c., and of astonishing the mind by certain most cunning feats of nature: but hitherto, to the best of my knowledge, no germination has been produced of only one metal, or of any single kind of metallic particles; thus no tree has been formed of gold alone, without the addition of mercury; or of silver alone, without mercury, tin, sulphur, &c.

Nature herself daily puts forth still more wonderful germinations from the bosom of the earth; and rears up in amazing diversity shrubs, trees, buds, leaves, flowers, fruits, and a thousand-fold play of objects, whose minute structure consists of salt, oil, spirit, water, &c.; principles which come over separately when plants are properly subjected to distillation. These cases prove, I think, beyond all doubt, that all growths of the kind derive their origin from the form, position, equilibrium, &c., of particles, and that there is nothing in them but occurs or is produced mechanically. If the particles of silver are reduced into their smaller constituents, and united with those of mercury, a crystallization resembling a tree never fails to shoot forth, and a similar result takes place with gold, tin, and iron; shewing that there is a peculiar union of the particles, which assumes such an arrangement or position as corresponds geometrically to germinations.

I imagine that no phenomena are better calculated to afford us an insight into the mechanism and shapes of particles, than those of crystallization. But the difficulty lies in the great variety of generic particles contained in the crystallizations mentioned above. Thus, in the *Arbor Lunæ*, there are not only particles of salt and of nitric acid, but also of mercury and silver, and perhaps also of water and the subtle matter besides. Hence, from a single germination of this kind, we have the greatest difficulty in examining, or rather conjecturing, the mechanism and form of the particles. The same may be said of the crystals of any metal, in which the particles of the acid menstruum, precipitating salt, and also of the water, are mixed with those of the metal itself. Hence it is difficult to determine geometrically what may be the figure of each substance, and how the general form and effect are produced. So also in the daily growths of the fields, there are not merely acids, nitres, and essential salts, but various kinds of oil, spirit, water, and other substances; whose mutual combination, the individual parts being unknown, completely baffles the mechanician.

But as to water, although it be quite pure, and free from any admixture of salt, oil, or other substance, still every winter we find it crystallizing and germinating in definite forms. I will now therefore describe a new form of the kind, which I observed as I was travelling in the winter season in West Gothland, in Sweden, not far from the episcopal seat of Brunsbo.

I saw that certain aqueous germinations had shot forth from the ice. Among these there were several in the exact shape of hexagonal crystals; but from which they differed, as their upper plane was not oblique, and also inasmuch as they were raised by a round stem from their base on the ice. The shape is delineated in Fig. 36, where the side *ab* is longer than the side *dn;* *e* is the trunk, *f* the base or ice; the part above, *abcd,* is flat; the ice was covered with these productions, and as I was much surprised, I took up a number in different places, and found that they were all crystallized in the same form.

Besides this germination, there were several others upon the ice, which rose to a height of one or two inches above it; some were like twigs, others like leaves, some stood upright like simple threads, others intersected each other transversely like lines, with a kind of sloping ridge. All these shapes, crystals, transverse lines, and other freaks of nature, may be seen in figured stones, whence we may in some degree arrive at a conclusion as to the production of such figures, which are frequently identical in the stones and on the ice. In winter, the panes of our windows are incrusted with a very delicate surface of crystallized ice, which frequently assumes beautiful forms, such as elegantly-curved stalks, bearing very sharp leaflets, like the fibres of leaves; and many other shapes artfully fashioned by the genius of nature and the mechanics of particles. The same phenomenon is exhibited by snow, which is nothing more than water congealed in the upper regions of the air; sometimes we find it in very thin flattened plates, but occasionally curled like leaves, sometimes in exactly hexagonal and star-like forms; or again, in globules, rough on the outside.

Since, therefore, we see that by the simple deprivation of fire, and consequently of motion in the interfluent subtle matter, the purest particles of water arrange themselves into these crystallizations, in which the forms, angles, and other qualities are manifestly geometrical, and especially since there is no heterogeneous substance to vary their texture and form, or to prevent the particles from assuming their proper forms; therefore it may be hoped, that by a skilful application of geometry the shapes of these particles may at last be discovered.

Let us only suppose, (as prejudices prevent us from asserting it more decidedly,) that the particle of water is round; and let us examine the geometrical combination of such particles, and we shall see most clearly the mechanism of the germination into hexagons, spirals, leaves, &c. Let us suppose, moreover, that the particles are rough; in which case they must necessarily be conjoined, when deprived of their interfluent matter.

A hypothesis of the figure and different magnitudes of Elementary Particles.

Nothing is more obvious to our senses than light, fire, air, and many other similar elements of the world; but, on the other hand, nothing can be more unknown to us than the mechanism of their respective particles. It is, however, certain that different kinds of particles exist; that there are particles of air, particles of ether, particles of light, and particles in which the magnetic power consists; and that each kind moves uninterruptedly among those of another kind, so that air may be set in motion without any impediment from the particles of fire and light; and light, without being disturbed by other particles; and so on.

The following rules appear to be conducive to the knowledge of those secrets of nature which are involved in the natural mechanism of particles. 1. Let us assume that nature acts by the simplest means, and that the particles of such elements are of the simplest and least artificial form. 2. Let us take for granted that the beginning of nature is identical with that of geometry; in other words, that the origin of natural particles is due to mathematical points; just as the origin of lines, forms, and the whole of geometry: the reason being, that there is nothing in nature but is geometrical, and *vice versâ*. 3. Let us suppose that all these elements can be put in motion at one and the same time, and in one and the same place, and that each will move naturally without being hindered by the others. If we found our principles upon these three propositions as axioms, I believe that we shall be more readily admitted to an exploration of physics, in which there is nothing artificial, or opposed to the rules of mechanism; nevertheless the exploration necessarily presupposes that, 4. Established facts be taken as a basis, and that we do not stir an inch without their guidance. Of this we may be certain, that whoever attempts to make nature out of the figments of his own mind, and to arrive *a priori* at the knowledge of effects in the posterior sphere, in other words, to form infinite nature with finite imagination, must either be wise as a divinity, or embrace the deepest shadows of darkness for light.

Let us therefore assume, 1. That nature acts by the simplest means. 2. That the beginning of nature is identical with the beginning of geometry, or consists of points and motion. 3. That many elements exist in the same place, as air, ether, fire, light, &c. 4. And that nature is to be investigated by the path of experiment. Let these propositions be granted, and let us shape our course accordingly. We now therefore suppose that air, ether, light, &c., consist of merely bullular particles, only differing in size; that is, that their diameters differ in the geometrical ratio of 30; thus, that the diameter of air being 1, that of ether will be $\frac{1}{30}$, that of light $\frac{1}{900}$, and so on. Let us suppose this as a mere hypothesis, the correctness of which we may doubt or deny, until we find that phenomena and experiments coincide with our position. The difference of dimensions is likewise only an assumption, which must be corrected by experiments, if the first or general position should hereafter be placed beyond doubt. Let us, therefore, examine this hypothesis according to rules, but only of the most general kind.

I. Reasoning from the principle of simplicity, I can scarcely imagine that there can be any simpler kind of particles than round bullæ. For, 1. They have no angle, save and except one infinite angle, comprehending all angles. 2. All the radii from the centre to the periphery are equal. 3. They have but one surface, and that a surface absolutely even. 4. Also a most perfect figure in which no inequality is found. 5. Therefore, since they possess the utmost evenness of figure, they also have the utmost equality of motion. 6. In a word, this form appears to be the simplest possible; so that if nature acts by the simplest means, she must act by particles of this shape. Consequently our hypothesis, which however I still call most completely in question, is confirmed by this argument.

II. If the nature of particles is derived from the same beginning as geometry, whence then does the line originate? Is it not from an infinity of points combined into length? And whence the surface, unless from an infinity of lines combined into width? Whence body, but from an infinity of surfaces combined into depth? The case is the same, if we suppose that in the beginning of all things, there were only mathematical points, without any shape, dimensions, motion, or geometrical attributes; and then suppose motion among these points. Here, however, the reader will object that no motion can be, until a surface or body be previously formed out of an infinity. I answer, that I take motion for granted; I assume it, and suppose that it is a central motion of the simplest kind; for it cannot arise unless the points have first been combined into a surface. Therefore, in assuming motion, I assume at least a coherent or continuous surface—a surface to obey the motion. Let us then assume a minute bulla, according to the hypothesis; then amongst these bullæ, or new bullular particles, motion may be conceived, both central, progressive, and vibratory. I shall elsewhere shew in detail the nature and extreme velocity of the motion in the bullular particles. Therefore, if the central motion be given, the whole surface, or the infinity of points constituting the surface, must have a force from the centre to the circumference, which is of course bullular. But if the enquirer demands the cause of this motion, I tell him that no finite mind penetrates, or can penetrate, into this; for the first motion must clearly arise from the Supreme Mover, from the Supreme Life, from God, the Creator of all things, Who, by means of His primeval motion, according to our axiom, impressed upon His world of nature the identical principle that governs in geometry.

III. Our third object will be to ascertain whether according to this bullular hypothesis, we can account for so many different kinds of elements agreeing together in one place and at the same time without interrupting each other. In accordance with what has been previously advanced, let the diameter of the particle of air$=1$, and that of the particle of ether$=\frac{1}{30}$; then the ether can flow with unimpeded motion among the particles of the air, and run wherever any force impels it. Let the diameter of the particle or ray of light$=\frac{1}{900}$, as compared with air; or $\frac{1}{30}$, as compared with ether; then the particles of light will move and run in the spaces and interstices of ether, and much more so in the interstices or on the surface of air (as will be mentioned hereafter). In like manner a still more subtle matter may pass between the particles of light, and so on. Thus we see that one element will move in an uninterrupted stream between the particles of another, and move both centrally, progressively, and in vibrations; and that the two will jointly occupy the same place; this being proved by experience. Still however let this be considered hypothetical, and exceedingly doubtful, until every experiment that has been made, or can be made, shall be found to coincide with the mechanism of our particles.

IV. But here perhaps the reader may demand at the outset, how particles of this sort can keep in their superficial position, and how the expanded bullular surface can move without laceration. But first tell me, 1. How the bubbles maintain themselves on the surfaces of fluids. 2. How soap bubbles can hold together and travel in the air for so long a time. 3. How vapours, which are bullæ, hold together, and, without bursting, mount to the upper region of the atmosphere, where they appear to unite into drops. Tell me the manner in which these effects can be produced so palpably. The following then are the reasons. 1. It is the nature of every element to press equally on all sides. 2. Therefore, when one element acts on the bullæ of another, the former presses from without towards the centre of the bulla, but the latter from within, from the centre to the periphery; and an equilibrium is produced. 3. Hence the particle of one element is maintained in its continuity by those of another, as by a chain constantly surrounding it. 4. Besides, it may be demonstrated geometrically, that the smaller bullæ are stronger and less liable to disruption than the larger, as we shall see hereafter.

V. Now should this hypothesis square with all the known facts of the nature of air, ether, fire, and light, as to their progressive, axillary, and tremulatory motions, as well as to their pressures and elementary signs and characters, we may then surely believe that it stands on a firm basis. But as each separate part of the subject requires a full explanation, I shall treat them one by one in succession. In the meantime our opinion may be considered as in the last degree uncertain, hypothetical and imaginary.

On the great power and intense motion of the smaller Bullular Particles especially.

Experience teaches us, 1. That when water is converted into bullæ or vapours, these remain entire, and rise without disruption into the higher regions of the atmosphere, although the air presses upon them with great force on every side. 2. Water enclosed in a glass vessel and rarefied into vapours by fire, has force enough to break the glass, and even stronger vessels. 3. Water in the form of steam will set an entire machine in motion, for instance, a wheel, as has been ascertained both in large and small engines. 4. If melted iron comes in contact with a volume of water, the water is converted into steam, and acquires such power, that the iron is thrown into the air, frequently to a height of twenty ells; nor does the violent action cease until the whole of the superincumbent metal is ejected.

From these facts we may infer, that if air consist of bullæ, it possesses an immense power of resistance, and cannot be broken by any incumbent weight; still less can ether, if it likewise consist of bullular particles; much less can the rays of light, and other particles, provided they be bullæ of a still smaller size: for their strength increases in proportion as their diameters decrease, or as their surfaces increase to their diameters.

I have stated hypothetically, that the particles of the fluid elements, such as air, ether, light, &c., consist of a bullular surface only, that is, are merely bullular or superficial; and that those of one kind are so much smaller than those of another, that the former will move with facility and enjoy a fluid state in the interstices of the larger. For the present, let this be only a hypothesis, and now let us see what geometrical properties in point of consistence and motion there may be among particles of such a kind. It may be observed, that,

I. Bullular particles are firm and consistent in proportion as they are small; that is, the smaller bullæ are much more difficult to burst than the larger, either by motion or impulse, as may be easily demonstrated. In Fig. 37, let AAA be the surface of a large bulla, BBB that of a small one, and CC that of one of the smallest size. On subtending the same angle in all, namely, *ef*, *cd*, and *ab*, we perceive that its first subtense is greater in the large than in the smaller bulla, in the ratio of the diameters. Hence it follows geometrically, that the part *ef* can be more easily bent and driven in than the part *cd*, and *cd* than *ab*, owing to the decrease of size. Now since the points of contact are subtenses of infinite smallness, let them be in the same ratio as the subtenses, and as the subtense of the same angle is greater in the larger than in the smaller circle, so it follows that if they move with particles of the same diameter, the larger will be more easily bent inwards than the smaller. We find also by experience, that a large glass globe is more readily broken than a smaller globe of the same thickness; so also, layers or plates equal to the subtense *ef* are broken with greater ease than plates of the subtense *ab*, since there are more points in the large body, as likewise follows from the nature of the lever. From this we conclude, that vapours are better adapted than large bullæ to maintain themselves in the atmosphere, and ascend to its higher regions without bursting; consequently air is better adapted than vapour, ether better still, and the rays or particles of light better still; and if there be a bullular element of greater subtlety, it will possess still firmer consistency, since the degrees of consistency are reciprocally as the diameters, or as the weights of the lever to the arms.

II. The central motion of the smallest bullæ is inconceivably greater than that of the larger, as follows geometrically from the same demonstration. When bullæ of the same magnitude move among each other, the central motion is rapid, in proportion as the points of contact are few; for these are what retard the central motion. When the smaller bullæ are reciprocally in motion, they have fewer points of contact than the larger. Hence we see the respective velocities with which the bulla of light, of ether, or of air, perform their central motions; and how greatly the flexibility or yielding of the bullular particles conduces to perpetuate the motion.

III. In the same ratio the tremulatory motion is most rapid in the smaller bullæ, and is as the squares of the diameters. In Fig. 38, let A represent a large bulla, and B a small one; let *abc* indicate the point of contact in the large bulla, or the distance to which its surface may yield and bend to the percussion of another bulla, so as to produce tremulation. Let *efg* shew the point of contact in the small bulla B. Here we see that if the larger surface *abc* be driven in towards *d*, the distance to which it is thus driven will be *bd*; but if, in the smaller bulla B, the surface *efg* be in like manner driven towards *h*, this distance will be *fh*. By the laws of tremulation, or oscillation, the velocity of the motion will increase as the length of the pendulum diminishes, the increase taking place according to the squares. Hence, since the intorsion or distance *fh* is to the intorsion *bd* as the diameters of their respective bullæ, the tremulation from mutual impulse will be as the squares of the diameters: thus we perceive how incredibly more rapid is the tremulation in the smaller bullæ than in the larger.

Although our position is only hypothetical and doubtful, let us submit these matters to calculation, namely, that the diameter of the bulla of air$=1$, and that of light$=\frac{1}{900}$. Hence during a single vibration of the bulla of air, the bulla of light will have vibrated 810,000 times, which is a little infinity compared with 1; and in still smaller particles, the vibrations will be yet more numerous.

Hypothesis of the Undulation and Vibration of Bullular Particles.

I by no means intend at present to undertake the defence of the bullular hypothesis, but I only add to it the supposition that air consists of large bullæ, and ether, light, &c., of smaller bullæ. This is a mere supposition. However, I wish to know the geometry of undulation in these different particles. I define undulation differently from vibration. Thus undulation is the kind of motion seen in water when it is moving in circles, but vibration is the reciprocal concussion of each particle with those near it. The former is connected with a local motion of the particles, the latter takes place without a local motion of the whole particle, but is a yielding and repercussion in the bullular particle in a state of rest. Hence, vibration is subtler than undulation, and does not move the entire surface of the element; on the other hand, undulation is larger and sets the surface in motion, as water by impulse, air by sound. Now let air$=1$, ether$=\frac{1}{30}$, and light$=\frac{1}{900}$, this being merely our hypothesis, it follows that,

I. When the air vibrates, it cannot make the ether vibrate, because the diameter of the particle of air is thirty times larger than that of the particle of ether. Hence, under these circumstances, the particles of air cannot strike a vibration in those of the ether, owing to the difference of size. Let A, Fig. 38, represent a particle of air, and B a particle of ether; let the vibration in the particle of air, by which its bullular surface is set moving, take place from *b* towards *d*: this distance *bd* we may consider as nearly equal to the diameter of the smaller particle B. Thus there is no proportion between the vibration of the particle A and that of the particle B.

II. But when the air vibrates, the ether may fluctuate and undulate; when the ether vibrates, an element with finer particles than those of ether may fluctuate, and so on. Thus the undulation of the lesser element is a consequence of the vibration of the larger.

III. Therefore when the air vibrates with sound, the ether undulates, and this undulation causes a vibration in the membranes of our sense of hearing. Hence we find that sound penetrates hard bodies, as stones, iron, and glass, through which air cannot pass. According, then, to this hypothesis, sound is a fluctuation or undulation in the ether, which can only arise from a vibration in the particles of air. Consequently there is no sound where there is no air.

IV. So likewise when the ether vibrates, the rays will undulate, and when the rays undulate, the ether will vibrate. Thus light may consist in the undulations of rays.

V. And again, when igneous bullæ tremulate, or fire is dilated into bullæ, the particles of light may undulate; the undulation constituting light. In a similar manner the vibration of light may give rise to an undulation in the particles of a subtler element.

VI. Moreover it follows, that the velocity of the undulation of ether is equal to the velocity of the vibration of air; and that the undulation of light is equal in velocity to the vibration of ether. This, I say, is a necessary consequence of our assumption. Nevertheless, we still claim for it no other title than that of a mere hypothesis.

Hypothesis of the Figure of the Particles of Fire and Air.

I am bound to give my views on these subjects only in the way of hypothesis, because all assertions regarding invisible things require to encounter many doubts, unless we should place an overweening confidence in our own opinion. As, therefore, I cannot assert, I shall only imagine or suppose; in order that in course of time, experiment may increasingly show whether my suppositions be in harmony with the truth or not.

According to our hypothesis, then, let the particles of air be bullular, with exceedingly minute particles of fire on their surfaces, as in Fig. 39 and 40, where *aaa* are particles of fire, very minute, and which we regard as not bullular, but round, and comparatively hard. But it may appear paradoxical to suppose that fire forms the crust of the air-particle, and at the same time a bulla, let us then consider the consequences of this assumption. 1. Let there be particles, similar to Fig. 39, on the surface of the atmosphere, where they are dilated, because there is no weight above them, to press them into a smaller space. Hence, in the highest regions of the atmosphere, on the tops of mountains, and above the clouds, we find that the air is very rare, and scarcely affords matter for respiration, or for supporting fire, and exhibits its usual phenomena in the poorest and thinnest manner: a great degree of cold is felt, flame is extinguished, menstrua do not act, and many other effects take place, according to experiment. 2. In lower situations, or under a certain height, these particles are more compressed, as in Fig. 40, and form a very thick surface or crust; for each particle is moveable, and one lies upon another, the pressure being equal on every side, according to the height of the column: hence they are compressed into a narrower space, and a thicker crust is produced. This view appears to coincide with experiment, for it is a well-known fact that air may be compressed by a weight, and it appears more compressed under a high than a low column, *i.e.*, at the bottom of the atmosphere. 3. There is less fire where the particles of air are more rarefied or distended: but more fire where they are more compressed, as indeed follows from the hypothesis. Thus in the same space, there is more fire in particles like Fig. 40, than in others like Fig. 39. This is sufficiently attested by experience. Thus more fire exists in the bottom of our atmosphere, than in its upper parts. 4. From the above figure of the particles it follows, that in our sublunary world there can be no flame without air; this likewise is proved by experience, for a candle goes out when the air is exhausted, and sulphur and other highly inflammable substances will not ignite at all in the vacuum of the air pump; furthermore, flame goes out gradually in very high situations. 5. In proportion to the renewal of fresh air, the flame is increased, as indeed appears from the shape of the particle. Thus if the crust of the particle of air consist of igneous matter, it follows, that there is more fire when the supply of air is large, provided it be fresh. This is seen if we blow into the fire, or the flame is fanned by the wind, when it burns with new brightness, on account of the fresh accession of air. 6. It likewise follows, that if there be a volume of igneous particles, that is, an element consisting of pure fire, it ought by its energy to decompose other bullular particles of the same matter, in the same way as water divided into minute drops, which immediately unite by contact with a larger volume, to form a part of the same. This is in some measure proved by experiments on fire. Thus the igneous element seems to decompose the air, from which it derives food for augmenting its own bulk. Hence the air is spontaneously attracted by the fire, the wind blows towards the flame, to nourish and increase it; which I think could not be, except by a resolution of the aërial particles into fire, analogous to that of vapours into water. In the same way, fire resolves or decomposes sulphurous, oleaginous, resinous, and all other substances, whose inner cavities contain minute drops of the particles of fire. In fact they are resolved into the fiery volume by simple contact, in the same way as water divided into drops reunites into a volume. Hence we find that fire increases from a small spark as though of its accord, and feeds on air, sulphur, oil, &c. 7. As soon as a volume of igneous particles returns into the atmosphere, these particles are again formed into particles of air; in the same way as water is converted into bullæ, as soon as it escapes into the air, just as when it is changed into vapours. This is consistent with experience.

For as soon as an igneous volume rises into the atmosphere, it is dissipated and dispersed, and as it were formed into new particles that supply more heat than those of common air. 8. The aërial particles are expanded by fire; for since it is the nature of fire to attract and resolve the adjacent air, a rarefaction takes place; and this rarefaction gives rise to expansion, and the formation of a vortex by particles more or less expanded. This may likewise be deduced from the motion of igneous particles on the surface of air. 9. Fire cannot exist in pure air only, or where there is an abundance of particles of ether, without being at once converted into small bullæ, as is proved by experience. Thus we never see flame in air by itself, nor igneous volumes alone, without hard and very compact bodies. Wherever any cavity exists, the fire is immediately transformed into bullæ; or, to express it differently, as soon as the fire comes beyond the pores of hard substances, it appears to form bullæ, or new particles, which are large in proportion as there is space. Hence we find that fire will live in hard bodies, and remain in them for a long time before it goes out altogether: also that flame is nothing more than the fire in hard particles which are flying off, or in fumes. 10. In the same way we shall be enabled to show, that there is a greater quantity of fire in the centre than on the surface, in hard bodies than in soft; and other phenomena in accordance with the nature of fire. Nevertheless, as it may still be doubted whether all those particulars which are, or may be, known respecting fire, will harmonize with this view of the subject, so we will submit it to the reader as a hypothesis only.

On the interfluent subtle matter between the particles of Water.

We find that water possesses the remarkable property of great fluidity when it is warm, and of great rigidity when cooled beyond a certain period; in fact, that the same particles present the phenomena of solidity as well as of the greatest mobility. No one, I presume, can deny, that this change is owing to the presence of an interfluent matter; for as often as heat is applied, the ice thaws, and its particles become fluid; as happens when it is placed over the fire, or during the spring and summer: on the other hand, whenever the fluid is deprived of its fire, the particles collapse into a fixed position. This fact amply proves that the fluidity of the particles of water is caused by some very subtle igneous matter of great mobility, interfluent between them, which separates them from each other, and prevents them from becoming fixed, holding them floating in its bosom in a state of suspension, and communicating its own mobility to them. This igneous matter also acts in a similar way upon the hard and more uneven particles of metals, whilst in a state of fusion; the difference between their fluidity and that of the aqueous particles being only one of degree. We shall see hereafter, from the same hypothesis, what kind of particles are interfluent between those of water and of the metals; experiments prove that these particles are but a peculiar matter.

1. When we inspect a piece of ice, we perceive that it is full of vacant spaces, apparently like globules, varying in size from a pin's head to a pea. They are arranged in a continuous series like spires, or little chains, and occupy nearly a fifteenth part of the mass. This appearance may be seen in any ice, except the icicle. Hence we may conclude that this subtle matter, whatever it be, is collected by the cold into granules or little drops, and leaving the spaces between the water particles, thus deprives them of motion and fluidity.

2. These concatenated empty spaces generally run perpendicular to the ice. For the element has the property of running into drops, when the little particles touch each other; just as takes place in water, when drops of it come in contact; also in oil floating upon water, in air, in certain barometers, &c. In like manner, this element combines into granules when fire and the solar rays are absent.

3. When water is frozen, we find that as much vapour exhales from it as when it is hot, if not more. This indicates that the interfluent matter flies off in the cold, and carries away the water in the vapour. What the nature of this matter is, we shall, God willing, set forth hereafter.

The mechanism of Bullular Particles.

Unless the mechanism of bullular particles be identical with that of elementary particles, the whole bullular hypothesis must fall to the ground. Let us see, therefore, whether the phenomena of the elements will harmonize geometrically and mechanically with the hypothesis of round particles. Let us then suppose that the elementary particles are round, those of water incompressible, those of ether compressible, and those of air consisting of igneous particles, as previously stated. And now let us inquire into the mechanism of such particles: let us figure to ourselves an ocean or lake filled with them, and that they are large enough to be visible. Now then let us apply geometry, by which, if it prove to be the same as in the mechanism of the elements, some doubts will perhaps be removed, and our thoughts be not a little cleared. But unless all the phenomena coincide with the view that we have taken, it is unworthy of any other designation but a hypothesis; nay, I will not bring it forward even as this, without adding that it is a hypothesis of the most questionable kind. Let us suppose, therefore, a place or reservoir full of these round and bullular particles, with a bullular and highly compressible ether in their interstices. Now it will follow from these mechanical conditions, that, 1. Every individual particle will run and be moved in its own place; that is, a particle of air will move upon its centre because it is round, and all the radii from the centre are equal, and there is no angle to hinder its gyration. When these particles move, there will be no upheaving or displacement of those near them: hence each particle, owing to its even or equal figure, enjoys an equality of motion, as indeed is clear in the element itself. 2. A volume of such particles is very fluid; owing to the mobility of each particle separately, and to the interfluence of the highly mobile particles of ether. 3. They are extremely mobile under the greatest weight; as for example, the particles of air at the bottom of the atmosphere, and those of water at the bottom of the ocean. 4. Bullular particles vibrate as well as undulate mutually; for since they are bullular, and the interfluent particles of ether are yielding and compressible, the re-percussion of one particle becomes that of another, the undulation of the one is also communicated to the other, owing to their mutual and constant contact. This is a consequence of the undisturbed motion or spherical shape of each particle. The same phenomenon is observed in this element. 5. Bullular particles are rapid in motion in proportion as they are small and yielding, like those of ether: that they are also strong and resisting in the same proportion, has, I think, been demonstrated above: we find that the same is the case in the elements. 6. These particles are pressed by the height or column of the superincumbent particles: this is a mechanical consequence, for as each particle is moveable in its own place, and can be separated from its neighbour, it follows that the upper ones will press upon the lower, and these again upon the lowest, according to their depth. But the case is different, if the separate particles cannot move in their own places; for one will then be raised from another in mutual entanglement, so that the ratio of pressure is no longer according to the depth, as may be seen in heaps of rough stones, in sand, and in buildings. But round bullæ, which are moveable separately, will act as we have stated. Now, again, we see the same in the elements. 7. Such particles press and are pressed equally in every direction, according to their altitude, which is also a result of the mobility of the individual particles, and it may be demonstrated geometrically how a volume of such particles is pressed on every side, and the pressure runs in a circle. Something similar may be observed in the elements. 8. A kind of horizon is preserved on the surface, and the particles do not go there in heaps, as we know by experience, and as follows from their equal pressure according to their depth. Again, we see the same in the elements. 9. It is from these principles that the pressure is according to the size of the base. 10. We have already shewn that there may be vibration among particles of this nature. 11. If we assume that the position, form, and nature of the particles are bullular, we can refer their undulation and reciprocations to the centre, their angles, round surfaces, risings, depressions, equality of distances and times, the plurality of undulations in one place, and their greater or less concordance with each other, and many other properties, to geometrical principles. 12. It cannot be denied that the conception of a volume of such particles will include the notion of transparency; for the light is nowhere broken by them; it does not go out or in through any prisms, cubes, or angles; it is not forced to alter its rectilinear direction anywhere, but enters and quits all the particles as if they formed one surface, and thus necessarily enjoys a regular passage and pellucid way. But as soon as the particles become angular, and of a prismatic, oblong, or other shape, the ray is forced to pass out by a different way from that by which it entered. The truth of this observation may be seen in large bodies, for when the most transparent substances are divided into unequal parts, and reduced to powder, they at once manifest colour: which phenomenon again fully coincides with the elements. 13. It is beyond doubt that nature is most simple, and acts by the simplest means: and there is no simpler figure than the spherical. 14. If then we choose to devise hypothetically particles of other forms, sinuous, serpentine, spiral, or fibrous, I confess that the notion will be deservedly ingenious, the inventors worthy of great praise, and their inventions cordially to be welcomed, if they can be referred to mechanical principles. For my own part I dare not yet advance this bullular hypothesis as genuine, for it is difficult to strike out any genuine novelty of undoubted truth regarding invisibles. Doubt must always attach, unless all the data that we possess at present, and all that may be discovered in future, coincide mechanically with the hypothesis; or unless an ocean of such particles, large enough to be visible, can be formed, and it can be shewn geometrically that they have the same properties as invisible particles of the same figure. There is still an infinity of data with which we are unacquainted; therefore I submit this opinion as a hypothesis, &c., &c.

On the centripetency of Heavy Bodies in elements consisting of Bullular Particles.

That an element presses according to its depth, and equally on all sides, upwards, downwards, and obliquely, is plain enough from experiments, as well as from the mechanism of particles, where each is separately moveable in its place, which may be conceived in an element of bullular particles, as shewn above. Let us therefore suppose that each particle possesses mobility, and consequently that the pressure is equal on all sides according to the depth; we maintain that the descent of the heavier, and ascent of the lighter bodies, may be conceived mechanically, as follows. 1. Let *g g* (Fig. 42) be an element. 2. Let H be a weight, greater or less. 3. The element presses on this substance according to the height of its column *abcd*. 4. But beneath, according to the height of the column *abef*. 5. Here we see that the pressure upwards is greater than that downwards, that is, the column which presses upwards is equal to the weight of the elementary column *abef*, whilst the pressure from above downwards is equal to the column *abcd*. 6. Hence the difference of the columns, or the part *cdef*, cannot remain in equilibrium, unless its weight is equal to that of a similar volume of the element. 7. If, therefore, its specific gravity be greater, the volume *cdef* will tend downward, for the pressure of the lower columns *ef* cannot raise it, by the difference between it and the higher column *abcd*; if, on the contrary, it be less, it rises upwards, because the pressure of the upper column, together with the weight *cdef*, cannot resist the pressure of the column *abef*.

This result may be better seen mechanically, by two levers. 1. Let there be two levers like a pair of forceps *ab* (Fig. 43), meeting in *c*, and diverging towards *d* and *f*. 2. Let the weight E hanging from the lever *d* equal 3. 3. Let the weight G hanging from the lever *f* by a string over a pulley, be equal to 1. 4. And within *ab* let there be another weight equal to 2; so constructed as to be hollow, and to allow mercury or any other heavy substance to be poured in through the aperture *m*. 5. If therefore the weight within *ab* equal 2, the levers will be in equilibrium, for as this weight presses upon the plate *b*, together with the weight G, which is equal to 1, they are conjointly equal to 3, and the balance is kept in its place without either ascending or descending. 6. If mercury or any other heavy body be poured in through *m*, so that the weight becomes more than 2, there is immediately a greater pressure upon the lower plate, which consequently sinks. 7. If a part be taken away, so as to reduce the weight below 2, it immediately presses on the upper plate, which rises. 8. A similar result takes place in the element, in which the pressure is equal both upwards and downwards: if then the weight contains more matter than is equal to the difference of its pressure, it sinks; if less, it rises.

If now an element and a surface be conceived, in which the particles rest one upon another, and are separately moveable in their places, and the surface is either circular or plane, it follows, according to the laws of mechanics, that in such an element the lighter substances will move upwards, and the heavier downwards. Thus, if the body suspended in the element contain more matter or compactness than an equal volume of the element itself, it will have a downward tendency. This however only occurs in those elements which have their own surface, and are so constituted that one particle lies upon and presses another. Under these circumstances it takes place immediately, according to the base and height of the column by which the pressure is caused. But should the reader wish to learn how such surfaces are formed in the vortices of the planets, and around bodies in motion, he must consult that physical searcher, and star of the learned world, Sir Isaac Newton, to whose researches all other investigations cannot but be inferior.

The notion of a Central Fire.

The opinion has been very prevalent that the nucleus or interior of the earth is hollow, and filled with a peculiar fire; and this has been attempted to be proved by the following arguments. 1. The earth appears to have been at first a star, which in process of time was encrusted, and formed a planet. 2. The earth is balanced in the solar vortex, which seems to be owing to an internal vacuum, whereby the crust might be balanced like a hollow globe of metal. 3. There are many volcanoes in existence at the present day, and formerly they were still more numerous: furthermore, there are thermal springs and boiling waters gushing from the bowels of the earth. 4. Minerals are formed, and metals, and many substances undergo various changes in the bosom of the earth; moreover flowers spring up, and the earth's crust becomes covered with vegetation. 5. And many mountains have been converted into lime, and seem to have been burnt up by fire. All these circumstances appear to prove the existence of a central fire, which in particular places bursts through the crust that encloses it.

I admit that it is undeniable that a certain subterranean fire really exists; that is to say, that in some parts of the earth's crust a degree of heat is perceptible, which causes thermal springs, volcanic eruptions, and many other phenomena: but whether this heat proceeds from the earth's centre, and whether there be a cavity full of fire, or an igneous void—this is to the last degree questionable, and for the following reasons. 1. Because fire cannot live, unless it be enclosed in hard bodies, as in carbonaceous matter already mentioned as shut up with the fire in a furnace. 2. But if the furnace contain no solid fuel, although it be full of flames, no sooner is it closed, than the fire dies out, lasting in fact no longer than the heat remains in the hard bodies. Consequently fire cannot be kept in a cavity unless solid substances be present. If, therefore, there be any heat in the centre (supposing a central vacuum to exist), such heat must come from the substances of the crust, instead of the crustal heat proceeding from the centre. 3. Hence we may conclude that heat exists in many parts of the earth's crust, and not in others: but as for its source, and the manner in which it is kept up, see the preceding observations on Thermal Springs.

As to the second argument, that the equilibration of the earth in the ether cannot be conceived, unless we grant the existence of an intensely hot, light, fiery void, which like a hollow metallic globe by its mere lightness attains an equilibrium in the external element, I shall only briefly touch upon it, because men of the greatest scientific authority have demonstrated that the contrary is the fact. 1. I shall shew elsewhere, God willing, that the more fire a body contains, the heavier it is, and that the gravity of fire is increased by the quantity; or, what amounts to the same thing, that fire is far more ponderous than ether, and consequently that the addition of fire is not the way to obtain levity. 2. We see the planets and our own earth move round the sun, as well as about their own axes, and in their own vortex, in which the satellites and moons are likewise balanced. 3. In the vortex we note a centripetal force, owing to which the heavier substances tend towards the centre, and the lighter towards the surface; and earth, water, air, ether succeed each other in regular order from the centre. 4. Let *ccc* (Fig. 44) represent the earth's crust, let *d* be the centre, which according to the opinion we are considering, is supposed to be empty, and very light, and let *aaa* be the surface of the vortex with the earth moving in it, beyond which there is a fluid ether. Now if we assign to the central cavity *d* the levity that ensures the equilibrium of so vast a crust, it will be more difficult to conceive how this equilibrium is produced, than if we place the levity in the vortex. Thus if the matter of the vortex *aaa* be lighter than the matter beyond it, the equilibrium will certainly be more intelligible. This may be proved by numerous experiments. 1. A stone or weight projected into the air, balances itself perfectly, as do all bodies in motion. 2. Also if these bodies are whirled round in the periphery of a wooden circle. 3. Water whirling round in a vessel does not fall to the centre, nor does mercury, though very heavy and mobile. 4. When mercury is placed in a glass vessel swinging from a string, its surface does not follow the slant of the oscillation. 5. If a weight be dropped down from the top of a ship's mast, and parallel thereto, it does not deviate an inch, or obey the course of the vessel. 6. If anything is thrown upwards in the ship, it falls down again in the same line, although in the meantime the ship may have advanced ten or twenty feet. 7. If any object be thrown from one ship into another, it passes in the same manner as if both vessels were stationary. 8. The same effect takes place in waggons and carriages: we see insects flying within them, as though they were in the most tranquil spot; and gnats likewise about the mane of the swiftest horse.

From all these facts it is evident, *firstly*, that solid bodies in motion will preserve their equilibrium in the air, or any other element, although there be no cavity within them to form the equilibrium; so also the earth. *Secondly.* That a vortex is generated about all moving solids, in which the latter are at rest, and the vortex only is in motion. Thus the equilibrium of moving projectiles and solids appears to result from a circumambient vortex, which holds these ponderous bodies in its centre, and goes with them through the line of direction with a given velocity, but they fall down, or come to rest, when the vortex is destroyed.

The remaining arguments, drawn from the existence of volcanoes, boiling springs, &c., and many other natural phenomena, are more satisfactorily explained by the crustal heat of the earth, than by a subterranean fire in its centre.

The phenomena of Phosphorescence and of the Ignis Fatuus explained according to the Bullular Hypothesis.

It is a curious circumstance, that phosphorescence and the luminous matter of wild fire, or ignis fatuus, exist equally in cold and hot substances. Thus, 1. Certain kinds of stones, especially gems, as diamonds, &c., shine in the dark. 2. The hair of some animals, as horses, cats, and dogs, is luminous when rubbed. 3. When mercury in a vacuum is shaken, it yields a bright light, like a fiery shower. 4. Decayed and rotting wood emits a similar light in the dark. 5. And common salt, when broken in the water, causes the luminous appearance near oars, ships, &c. 6. Likewise when certain hard substances, as some kinds of salt, sugar, &c., are broken in the dark. 7. The shooting and falling star in the air, which so closely mimic the true stars of the firmament. 8. Marshes produce the most brilliant wild fires: I have seen some of these wandering flames as large as a lamp; which sometimes went out, and then were lit again, moving about from place to place, and two or three visible at once over snow and water; and more vivid and ruddy in the coldest air than at other times. I have often watched them with delight for a long time at a distance of a hundred and twenty feet. These fires are commonly called fire-dragons, and treasures are thought to be concealed under them. 9. So likewise the effluvia of metals shine like a candle or white flame, as may be seen anywhere in Sweden. 10. The eyes of cats shine in the dark. 11. And glow-worms, especially in rainy weather. 12. Phosphorus, prepared from urinous substances. 13. Cylinders smeared with bituminous or sulphurous matters, and rubbed upon cloth. 14. And empty globes moved rapidly round their axis, the cavity of which appears to be on fire inside from the action of effluvia. In hot and dry substances these phenomena are still more evident. Thus, 1. Heat first and then light are excited by motion, as by the collision of flint and steel, by the friction of a hard and of a soft piece of wood together, of hard and soft stones, and a thousand other things. 2. A nitrous powder, which goes off in a flash when it comes in contact with the air, is formed of charcoal that has been shut up for a long time. 3. Besides other species of phosphorus, which catch fire in the air. 4. Not to mention that fire itself is kindled into flame, and the very atmosphere is lighted by the sun, in cold weather not less than in hot.

According to the bullular hypothesis, it follows that light is nothing more than undulation of the rays, or than vibration of the ether. It has already in some measure been shewn that the rays undulate when the ether vibrates. In this fact we have the explanation of phosphorescence and of the ignis fatuus, both in cold substances and hot, in dry as in moist, &c.

It would appear that the exquisitely minute particles of ether cannot exhibit the phenomena of light, unless they are struck by particles equally fine and small. If the latter be too large, nothing more than a slow and exceedingly dull undulation will take place in the former; but the reverse if both sets of particles be of one smallness. Thus, 1. The ether may be set vibrating by mercury with its very minute particles, especially in a vacuum. 2. In like manner the ether may be made to vibrate, or the ray to undulate, by any very subtle exhalations, either whole, or decomposed in the air, for instance, by saline *ramenta,* by urinous and sulphurous matters, provided their particles be extremely minute. 3. By the most delicate ramenta of salts, when broken, as in the sea. 4. By decayed wood, whilst emitting subtle particles. 5. And by the effluvia of certain animals excited by motion and friction. 6. I need hardly say, also by fire, whose particles are so amazingly subtle, and when undulating will cause an undulation in the rays, or a vibration in the ether. 7. So also the rays from the sun will undulate through the whole sky. Hence according to the bullular hypothesis, it appears, for the reasons already stated, that light may arise in cold substances as well as in hot, and in the dry and the moist alike.

The sensation of sight points in a manner to a similar conclusion. The sensations that we have appear to be nothing more than the very subtle motions in the smaller particles: and as the most subtle motion amongst such particles can hardly be other than undulatory and vibratory, so I do not know why those persons should be mistaken, who maintain that sensations are merely vibrations or very subtle motions in the membranes of our frame. It does not seem possible that the light in our eyes can be, 1. Any quiescent or passive thing. 2. Or any occult quality, for we find in the organ a mechanism for receiving the rays. 3. We see the internal tunics or meninges brought from the interior of the head, and exposed immediately to the rays. 4. We see a variety of different tunics and fluids in the eye. 5. In the inner part, where the rays are collected, we observe a reticular lining, so that no ray can escape coming in contact with a considerable portion of the membrane therein. 6. We find these membranes conjoined with the internal membranes, and the rays received communicated to the meninges of the brain. 7. As therefore sensation must consist of some motion, and as the smallest motion is the vibratory and undulatory, I am not aware that there is any impropriety in assuming that sight or vision consists in the undulation of the rays in the membranes of the eye. 8. In the same manner as sound, which we know for certain is produced by the undulation of the air; for the ear is mechanically formed for its reception; it is tortuous, furnished with membranes, a tympanum, cochlea, various nerves of the utmost delicacy, malleus, incus, and all the apparatus necessary for vibration. These subjects, however, will be treated upon elsewhere. At present it is sufficient to have pointed out, that light is nothing more than a motion of the smallest particles, that is to say, of rays; and as the vibratory is the most subtle motion, we may perhaps find fresh proofs of the existence of light in the bullular hypothesis and the principle of the undulation of rays. But as we are treating of invisibles, and as thought and geometry are alone at our service in the investigation, so we will submit our views to the criticism of the learned; and if they can bring forward facts to refute our notions, we shall receive the information in the most grateful spirit.

On the increments and degrees of Heat in Bodies, according to the Bullular Hypothesis.

The wonderful nature of heat and igneous particles is also plain from the fact, that heat increases more in solid and compact than in soft substances. Thus, 1. If wooden boards be exposed to a powerful summer sun, a much greater heat is perceptible in them than in the air. 2. If sheets of iron or copper be substituted for the wood, the heat is still greater. 3. I exposed flat pieces of copper, iron, stone, oak and pine timber to the action of the sun from daybreak until two o'clock in the afternoon, and the air was found to be pretty warm, though not by any means sensibly warm to the touch, like warm water; the pine timber was hotter, the oak hotter still, so that the hand could scarcely bear it; the stone was middling hot, but the copper was too hot to touch. 4. On repeating the experiment, I discovered that these substances varied in their degrees of heat according to their bulk and the thinness of the plates; that is to say, in the same time and from the same fire, a large body did not absorb the degree of heat proportioned to its compactness so quickly as the same body divided into plates; and therefore the experiment was most successful when the plates were of equal thickness. 5. The same fact may likewise be observed in charcoal, for the lighter kinds yield less fire than the heavier, pine charcoal less than beech, and beech less than fossil coal; so that the same amount of fusion may be performed with a smaller quantity of the heavier sorts. 6. And in domestic fires, the lighter woods afford less heat than the heavy; and in the walls of the stoves, the lighter stones supply less warmth than the heavy. 7. And in the large furnaces used in iron, copper and silver works; which do not receive their full degree of heat in less than six, eight, or fourteen days, owing to the bulk and thickness of the wall: but as soon as they have obtained it, more ore and metal is melted near the wall than elsewhere. 8. In like manner mercury will receive a hotter fire than any other liquid. 9. The same rule holds in cold substances. Thus on exposing the same plates to the wintry sky, the air being very cold, snow is found to be still colder to the sense of touch; but iron is so intensely cold as to adhere to the skin, and almost to tear it away from the finger. I have not yet observed the effects of cold on the different kinds of wood, and on the metals. 10. Mercury is susceptible of most intense cold. 11. Water of the same temperature as the air is felt to be colder than the air; when cooled it freezes into ice, and is still colder than the air. 12. From these facts we may to a certain extent conclude, that the same heat and the same cold are much more increased in dense than in soft bodies, and that they are in proportion to the size of the pores; hence that in porous substances, as timber, scoriæ, bricks, &c., heat and cold are not circumstanced as in compact substances; or in old hard bodies as in recent, or in the elements and fluids as in the solids. These facts may be explained by the bullular hypothesis on the following mechanical rules. 1. We have already said that when the igneous matter is set in motion, it forms into bullæ; as also follows mechanically from so very intense a motion of the smaller particles, as in the case of water and other fluids. 2. It will be seen hereafter that the particles of fire enter through the finest pores, and make their escape through the larger. 3. Therefore, in proportion as the pore is small, the greater is the surface compared to the space, and the greater the quantity of particles that enter it. 4. If then these particles form into bullæ, the bullæ will be small in proportion as the particles are numerous. 5. The smaller the bullæ, the greater will their motion be. The smaller the bullæ, the less will be the volatilization, because the volume will be so much the heavier. And *vice versâ* in the larger pores, for they have less surface and more space, and consequently contain a smaller quantity of fire. 7. In proportion as there is little fire, the bullæ are large and dilated. 8. In proportion as the bullæ are large, their velocity of motion is less, and their volatilization is rapid, because in the same proportion they are light. Hence there is a larger measure of heat in compact bodies, than in others of less density.

But the sources from which the matter of fire may come, have been pointed out in the preceding pages. 1. From the resolution or decomposition of air. 2. Its particles are inclosed in oily, nitrous, sulphurous substances, and in general in the small channels and pores of things. 3. They are set free by any moving volume of the same igneous matter. 4. And they enter through the minutest pores, pass into the minutest cavities, and form bullæ, and then exhale through the larger orifices. Each of these points will be considered in our Theory of Fire. But as most of the experiments are still wanting, and as we are treating of minimal and invisible things, so we can only advance our views at present hypothetically and doubtfully.

PART IV.

OF THE

MISCELLANEOUS OBSERVATIONS

CONNECTED WITH

THE PHYSICAL SCIENCES,

AND ESPECIALLY

ON THE MINERALS, IRON, AND THE STALACTITES IN BAUMANN' CAVERN.

THE ORIGINAL PUBLISHED AT SCHIFFBECK, NEAR HAMBURGH, IN 1722.

To His Most Serene Highness, LUDWIG RUDOLPH, *Duke of Brunswick and Luneburg.*

Most Serene Prince,—

THE following pages are too unimportant to constitute a worthy offering to your Highness; at whose feet the great works of the masters of learning alone are deserving to be laid. But as small things frequently afford pleasure to illustrious men, and as your Highness is aware that victims of slender value were presented at the altars of the gods, and that a little frankincense was offered in propitiation to their divinities, so I also, encouraged by such great precedents, am not without hope that these few pages which I have ventured to dedicate to your most Serene Highness, and to place upon your altar, may meet with a gracious reception; were it for no other reason, than that in part I present you with your own, with a record derived from the Baumann's Cavern, to which my access was your own most gracious permission. And still the greatest reliance that I have in supplicating your favour, is in the knowledge that you are as illustrious in spirit as in descent, as distinguished in mind as in renown; and that the world accords to your personal virtues the same free honour as to the extended sway and imperial diadem of the Cæsars.

But if the offering that I bring is small, my veneration at least is greater than the offering; nay, so great, that I desire nothing more ardently than to be permitted to be,

Most Serene Prince,

Your most humble and devoted servant,

EMANUEL SWEDENBORG.

MISCELLANEOUS OBSERVATIONS.

PART IV.

On a new Sexagenary Calculus, invented by Charles XII., of glorious memory, late King of Sweden.

As the adventures, actions, and lives of illustrious men in the learned world belong to the history of literature, and constitute its glory, especially when they are at once illustrious in mind and by heroic deeds, (for such are worthy of double laurels, of one wreath for their genius, and the other for their fortune and birth,) so I consider that what I am about to relate of the sexagenary calculus invented by King Charles XII., of glorious memory, will be found highly worthy to be recorded and remembered. I suppose that not one man in a thousand would imagine that a hero of such renown, gathered from so many achievements, possessed also a most profound and acute judgment, and a force of mind the most penetrating in all matters belonging to arithmetical calculation. But it was my good fortune frequently to hear him discourse on such subjects, in particular, as belong to mathematics and arithmetic, and I will now give an account of a mode of calculation invented by him, which will afford a sufficient example of his power.

One day the conversation happened to turn on the nature and origin of arithmetical calculation, and the method in general use was shewn to be only an artificial, and not a natural plan; that is to say, that the simple numbers run in one series up to the tenth character, then in a double series to twenty, and so on through the third, fourth, and other numbers, to a hundred, and to 1,000, 100,000, &c. It was remarked that this method had arisen from some ancient custom of counting with the fingers; for when the rustic and simple people of early times had reckoned up to the last finger, they began again in a new series, and again arrived at the same point, by following their ten fingers, and so on until they had thus gone over them ten times; which would be denoted by conjoining two marks or fingers, then three, four, and so forth. Afterwards, when this method of calculation was distinguished by numbers, it would of course keep its original character, after having been so long received in practice, and taught on the fingers. The difficulty of devising any more expeditious calculus was also an additional reason for the general adoption of this method; hence at the present day, we make use of that system whose limits and periods lie in the decimal number. But had a geometrician, or a person well skilled in the fundamental principles of arithmetic, been appointed to furnish the world with a method of calculation, of greater utility and convenience, he would never have selected the decimal system, but rather have based his plan upon some other number, which by dividing or halving would constantly return to the beginning of the calculus, or to unity, and which would have contained the square or cube of some number; or which would have been more in conformity with our measures and weights, and with the divisions of money. Many other particulars were mentioned, with which his Majesty was so greatly pleased, that he immediately desired to make a trial with a calculus of a different nature or order; but as this could not possibly be accomplished unless additional numbers or characters, with fresh denominations, were provided, he at once began with the octonary scale, which, as he observed, would not only return by halving to unity, or the commencement of the calculus, without any fraction, but would likewise contain the cube of the number 2, and when doubled or quadrupled, would agree with certain weights and series of coins up to 16 and 32, received in general use. He therefore commanded me to attempt an example of this new calculus, which I accordingly prepared in the course of a few days, with the addition of those points of agreement which the octonary scale would possess with the coins, weights, and measures in use at present, together with an easier method for finding the cubes, squares, and other calculations more speedily: in short, I mentioned everything which appeared to illustrate the new attempt.

When his Majesty had looked at my specimen twice or thrice, although he saw that it clearly had certain advantages unknown in the decimal calculus, yet he would not honour it with his approbation, because, as far as we could judge, he considered it too easy both in conception and practice. He therefore immediately said, that he wished some other number than eight to have been selected; some number, in short, which might contain both a cube and a square, and yet be referred to the octonary scale, and reducible to unity by constantly halving. As the number including all these conditions could only be 64, which contains the cube of 4, and the square of 8, and by halving is reduced to the commencement of its series, or unity, without leaving any fraction, I ventured at once to object that such a series of numbers would be far too long; and that to proceed uninterruptedly by simple numbers to 64, then in a double series to 4,096, and then in a triple series to 262,144, before the fourth term would begin, would occasion an incredible difficulty in calculating, not only in subtracting and adding, but especially in dividing and multiplying. For it would be necessary to commit to memory 3,969 numbers for the multiplication table, whilst the octonary scale would require only 49, and even the decimal no more than 81, which is yet a wearisome effort for some persons to remember and apply. But in proportion as I raised difficulties, his Majesty only became more eager and desirous to try this calculus, *Per ardua visus est velle niti*; he seemed to court difficulties, and would give no other reply, than that those I had alleged would be compensated by greater advantages.

A day or two afterwards, I was once more summoned before his late Majesty, who resumed the subject of this new calculus, and enquired whether I had attempted it? As I was again bringing forward the difficulties already mentioned, his Majesty took from his table a paper, containing new characters and fresh denominations for numbers, in his own hand-writing, which at my request was handed to me; and to my great astonishment, I saw he had invented not only new characters and numbers (bearing a considerable resemblance to the letters of his own name), and which proceeded in a regular series to 64, by a most happy and easily-remembered division, but likewise fresh denominations; both being so contrived that they might be extended to myriads, whilst the character and denomination would constantly vary. But when I perceived collaterally some new methods for performing addition and multiplication by this calculus, which were produced artificially, or by characteristic marks in the numbers themselves, together with other most ingenious attempts to facilitate the employment of this system, I could not but admire the heroic force of his mind; and, full of wonder, I felt obliged to confess that this great monarch and man was not merely my rival, but my conqueror in my own department.

And as I am still in possession of the manuscript in the royal hand-writing, and as we ought to commit to the safe keeping of the press all those subjects which are most deserving, so I shall, at a future opportunity, lay these characters before the public, together with the methods of calculating with them. They will certainly shew what an active faculty for device his Majesty enjoyed, and how profoundly he had penetrated into the deepest secrets of arithmetical science.

Another proof of his skill in calculation was afforded by the ease with which he could solve the most difficult problems by mental operations simply, which would have required from others the most laborious and fatiguing methods. And here we may just notice, that when he was at Bender, he composed an entire volume on military exercises, which is highly esteemed by the most able members of that profession. Hence also, when thinking of the benefits derived from mathematical and arithmetical science, he used to say, That he who could not calculate was scarcely half a man.

Reasons to shew that Mineral Effluvia or Particles penetrate into their Matrices, and impregnate them with Metal, by means of water as a vehicle.

There are many opinions respecting the impregnation of matrices and the generation of metals in the bowels of the earth; and as the causes and origins of these results are remote from our sight, they must be investigated by hypotheses or ideas, assisted by the numerous examples which present themselves in every direction to the notice of the enquirer. We have to consider, then, what it is that conveys the effluvia, and what it is that insinuates the metals and sulphurs into stones.

It has been ingeniously supposed by many persons, that there is a peculiar fire, solar or central, that penetrates into the most hidden recesses, and enters the minutest pores, together with the subtler exhalations, and thus enriches stones with metals, by filling them with certain heavy and foreign particles. That this effect is produced by the solar fire, may perhaps be doubted, for the following reasons. 1. Because the veins very frequently appear to be richer in the deepest and most hidden parts than near the surface; and it is hardly consonant with reason to imagine that the solar rays can reach these places, and penetrate to such a depth towards the centre of the earth, especially as there are obstacles, not only in water, but likewise in the very diverse parts of the soil and in compact rocks impervious to the solar rays, and of the coldest temperament; all of which would at least deaden and impede the heat issuing from the sun, or prevent it from proceeding to any great depth. 2. The rocks are as rich in metal in the coldest parts towards the north, as in countries near the equator; in Lapland and in the north of Sweden, the veins are often richer than in the south. But if these veins derive their origin, or form an influx, from the sun and its rays, the latter being supposed to contain a subtle sulphur, and to pass from the fiery oceans of the world through the atmosphere into the lowest region of the earth, then we must first ascertain whether a very oblique sun, as in Lapland, can produce the same amount of effect as a more perpendicular radiation? And here I need hardly remark, that three-fourths of the heat (if the influx be deduced from the heat, and not from the rays) will be entirely stopped in its course by the cold that reigns during the year, and binds up the mountains. 3. We may also add, that wherever any metallic vein is found, especially if it be rich, experience testifies that the climate is sensibly colder, and a wintry sphere exhales from the very mountains. Thus, if we take the Saxon, Luneburg, or other mines, how intense is the cold in those localities! the case is the same with the Swedish and Lapland mines, although the surrounding district may have a comparatively warm and vernal atmosphere. Hence, also, mineral mountains are generally covered with snow, whilst others in their vicinity are gently moistened with the dews of spring; the air is felt to be cold on the mineral mountain, when it is temperate on a neighbouring elevation of equal height. To pass over the innumerable instances which Sweden affords, I remarked that at a little distance from the mines of Eisleben, the atmosphere was of a temperate and agreeable warmth, but that it was very cold where the works were carried on, although they were not a quarter of a Swedish mile distant, and scarcely any higher. A similar difference was observed during the winter season in many other places. Thus it appears that the mineral mountains are not impregnated by either the solar or central fire or heat, since they partake less of heat than of cold, and emit effluvia rather than admit them. If therefore cold and heat could in any way agree, we might then perhaps conceive that by the action of the heat derived either from the sun or from the centre of the earth, particles might be carried into the veins, which may in themselves be cold, and which seem to be perceptibly so in various places.

I am not at present speaking of the origin of the effluvia or exhalations, but only of their ingress into the veins: should any one be inclined to deduce the origin of the particles from any kind of fire, above or below, I shall not here oppose him. Nor shall I object to any one concluding that there is an influx of metallic particles from the rays of the planets, or from the lightest and most mobile rays of the sun, which may still be extremely cold.

In support of our opinion, that metallic exhalations and particles penetrate into the rocks and impregnate their matrices through the medium of water, several probable reasons are derived from the following circumstances; which will, I think, prove experimentally, that the same effect may be accomplished by the action of water, as by the subtlest particles of the sun or of any central fire.

1. We find that some waters are strongly impregnated with the effluvia of various metals, and that they generally run from the clefts of those mountains that are rich in veins of the same metals. Many of these springs exist in Sweden, Germany, and especially in the country about Liège, at Spa, in Hungary, England, and elsewhere; consequently it is undeniable that the effluvia and subtler particles of the metals frequently lurk in the aqueous particles. So great is the profusion of springs impregnated with vitriolic matters, with iron, copper, silver, and many other mixtures and species of metals and salts, that to enumerate them would be a long and useless task. Thus we see that the very subtle particles of any of the metals may be easily hidden amongst those of water, flow with them, and in their company pass through any substances they meet; in short, that the one order of particles holds a natural place among the other. 2. And experience demonstrates that this is not peculiar to metallic particles alone, for it also obtains with every description of vitriolic, aluminous, nitrous, and other saline particles, which not only will accompany a volume of aqueous particles, but will live and travel in it naturally. 3. It is still more extraordinary, that even sulphur and oil, which otherwise will hardly mix with watery fluids under any circumstances, are found mingled with these waters; and that, so intimately, *i.e.*, in such minute elementary particles, that when the water stirs, they emit their peculiar odour, much as under the action of fire; as abundant experience shews to be the case with medicated and vitriolated waters. It appears, therefore, that the subtlest particles of sulphur, those nearest to its infancy and origin as a substance, accompany the aqueous particles, and penetrate into the same places with them. But when the same sulphur has coalesced and formed larger particles, it is hardly miscible with the aqueous particles; for this combination only takes place whilst it is very minute, and has not yet assumed

its peculiar fixed nature. 4. This view may be confirmed by additional experiments; as by the solution of metals by the appropriate menstrua. Thus, by the assistance of certain acids, gold itself, silver, copper, and the other metals may be dissolved and rendered fluid in water. Mercury, without any other menstruum than simple hot water, may be divided, and assume somewhat of the same fluid property as the water. The whole of these experiments prove that the subtlest particles of the metals will remain in water, as their own natural fluid, and will make use of it as a vehicle to penetrate in every direction: likewise that the metallic particles or effluvia may exist in the waters, and pass with them through the clefts and crevices of the rocks, and thus, as we have said, by the medium of water, run into the matrices of metals.

It now, on the other hand, is necessary to shew, that water itself has the power to pass through the subtlest pores of stone, and to run in every direction, upwards and downwards, through the clefts of rocks. That such is the fact, is evident from the following reasons. It is well known, 1. That water will enter the smallest pores, into which air and still subtler matter cannot penetrate; thus waters will insinuate themselves readily into the pores of stone, in sufficient abundance sensibly to increase the weight of the mass. I have frequently seen this experiment tried with stones which had been immersed for a considerable time in the beds of rivers, and with fragments of rock blasted by gunpowder from the roofs and sides of mines, and the water has often exuded from them in considerable quantity; consequently its particles must be subtle enough to run freely into stones, especially into those which have wide pores. 2. Nor does it penetrate into stones alone, but also into certain metals, as into the pores of copper and iron; and experiment shews that warm water may be driven even through gold. That water passes through the clefts and strata of mountains, both upwards and downwards, is sufficiently proved by the following experiment. Take two flat surfaces, and apply them accurately to each other, so as to allow no passage for air; on immersing one end in water, the fluid immediately rises as though spontaneously, and comes out at the upper end, and this with rapidity when the passage has been once moistened. The same effect takes place in ashes, in all spongy substances, between the closest fissures of the strata, and in other fine apertures. Whence it may appear, that water will penetrate the subtlest pores of rocks, and especially those stones which are divided into layers or cubes, &c.; that it rises along the strata, both upwards and laterally or obliquely, in a vacuum as well as in the atmosphere; in short, that it has the power of running into the more porous kinds of stones, as in matrices, which will be again remarked in the following pages.

But this possibility will not yet allow us to form true and dogmatical conclusions, or boldly to assert that metals are carried into their matrices by the sole instrumentality of water; unless, indeed, we can maintain ourselves by experience, and confirm our position by reasons grounded in the first instance on probability. Of such reasons the following are examples. 1. Aqueous exudations exist in most mines, in considerable quantity in some cases, more sparingly in others: and we observe that liquids drip from the veriest hard rocks, covering and moistening the sides and roofs of the mines, although not a crevice is visible in any part. 2. In some mines the water is accompanied by a vitriolic, or genuine metallic, or sulphureous salt; as at Fhalun in Sweden, and at Gosslar, where the walls are frequently encrusted with saline deposits, which sometimes depend in drops like icicles; so that it is plain that a peculiar juice permeates the pores of the rocks, and carries with it the metal or salt, which thus gradually insinuates itself into its matrix. 3. In mines consisting of strata, we may constantly see the water flowing, or see that it once flowed at the borders of the strata of rock, and that wherever a passage was afforded, it has insinuated itself into the interior of the stratum. And this water seems so highly impregnated with metallic particles, that its colour, weight, and taste enable the miners to form an opinion on the condition and quality of the ore in the strata. 4. The surfaces between these strata and the rocks are generally covered with a species of clay, the strata being actually softened into clay, and at the same time distinctly coloured. All these indications shew, that the water had constantly trickled between the strata; and being impregnated with metals, had everywhere penetrated into those matrices or stones, whose pores are the best suited for its reception. 5. Moreover, this water often gushes forth from the surface, and forms a fountain or spring, which is impregnated with similar substances, as vitriol, sulphur, alum, iron, copper, silver, lead, &c. 6. When we examine the matrices, of which whole strata are often formed, such as spar, quartz, dropping stone, &c., they are found to consist of continuous layers, either of cubes or triangles, in the interstices of which the water passes in every direction. Thus it seems to enter at the edge of the stratum by the planes of apposition, and in course of time to fill them with the metallic particles that it has brought with it. Hence those stones seem to be the best adapted for matrices, which consist of the above cubes and layers, whose interstices afford a passage for the water which it does not find elsewhere. 7. Hence also we remark that the spar, &c., varies greatly in colour; being white, red, or shining, according as it is dyed by different coloured waters: the weight likewise varies, some spars being lighter than others, and they are often found to differ in these respects, according as they are near the vein, or more remote from it. Besides, we perceive most clearly in ores that effluvia insinuate themselves through the thin layers of the stones, or the interstices of the cubes in quartz, spar, &c.; so that the very layers themselves appear to be divided and denoted by the ore, which afterwards by the medium of the same water creeps transversely and obliquely into all the planes of the layers, until it occupies the entire mass. 8. Hence, also, we have ores as brilliant as spar, which are frequently rich in metal, as iron, lead, tin, silver, &c., and many others, which prove that the water enters along the minutest flat surfaces of the layers into the matrices, and carries the metallic particles with it. 9. This is still more visible in scissile stones full of ore, as in those of Eisleben and other places; in which mines the ore is only found on the surfaces of the layers, which shine with sulphureous, golden, coppery, and other glowing tints. Nor do the exhalations seem to have penetrated into the actual substance of the stone, but only between its layers, or into those parts which were open to the permeating streams, and through which the fluids rise upwards, according to repeated experiments; in this manner fresh metallic intermediate strata appear to be formed. So also in mineral stones partly consisting of another kind of rock, we find that the surfaces are usually occupied by sulphur, vitriol, or metal, which gradually extend from thence into their interior; that is to say, these substances originate in those places, through which the water, it seems, can run and carry the metallic particles with it. 10. Nor should we omit to mention, that the richest veins are covered with stagnant water; yet not constantly; although experience certainly shows that where the rocks are comparatively rich in veins, adjacent parts, both above and below, are moister than elsewhere; whence the wildfire or ignis fatuus is generally seen in marshy places. 11. Do we not often find the more porous stones full of real native silver and copper? Do we not often see pieces of wood impregnated with these metals? I myself have seen the trunks of oaks, beset with true copper all along the filaments of the wood where water formerly ran; and I have noticed fir timber injected with silver in the same manner, with many other substances, affording a passage for water only, which had deposited in those places the particles that it held in solution. This is still more clear in those places where specimens are found preserving the shape of fish, the whole form shining with copper; which is a sufficiently evident sign that the water had permeated the fissures and interstices, and in its passage had covered not only the surfaces with very delicate plates and incrustations, but had likewise deposited the same materials in the interior of the fishes, &c. 12. And if we consider the native crystallization of metals, we recognize the same traces and forms that we daily see produced by the agency of water. Thus, sometimes they appear as filaments, issuing in straight and oblique lines from their crevices or matrices, through which water of some kind seems to have oozed, and generated long icicles and capillary formations. And do we not also find that the metal grows from the same stone as the crystals? which, it is pretty well agreed, derive their origin from the vapour of some watery fluid. Moreover, we often see crystals covered with the ore of some metal, which occupies either their interstices or their external surface, or endeavours to disengage itself from their inner substance. All these circumstances seem to point out, that both the crystals and the rudiments of these ores are formed by the agency of some fluid. And do not some vitriolated waters contain so much copper, that the latter exceeds the iron in amount? This cause is the more likely to explain the generation of metals, as there may be a subtle sulphur lurking in the waters, together with vitriol and many other substances, which give rise to marcasites first, and then to metals. For if sulphurated water passes through porous stones, it would not be extraordinary for the more irregular particles to remain in the pores, and for those which are comparatively regular to pass onwards; in other words, the sulphur, vitriol, and metallic particles may occupy the minute spaces, when the water that was their vehicle escapes. 13. If we examine a single metal, and its mode of growth, as silver for example, we find that its ore is of different kinds; sometimes the red species of silver ore exists in crystals, as though these crystals had been produced in the same way as stony crystals, by the action of a fluid dropping from a rock. We see native silver in thin plates, or in capillary filaments, or in branches and very elegant arborescent figures, having a root in the matrix, from which they spring upward in luxuriant ramifications. All these circumstances point to the existence of a peculiar fluid that generated the figures we have mentioned, and arranged the particles in definite forms and positions. This appears to happen in the same way that silver, when dissolved in a menstruum with mercury and water, or some precipitating salt, gives rise to the *Arbor Lunæ*, or tree of Diana, or to hexagonal crystals, or thin plates. Since these are plainly produced by the instrumentality of water, we may conclude that the others also are due to the same agency. 14. The same variety is very evident in the other metals likewise; thus a vein of lead, and of tin likewise, often forms crystals of different colours: and I have seen the ores of iron, and again of other metals, possessing the same forms as the crystals, both therefore having the same origin; and as the crystals are produced by a fluid exuding from the rocks, so it may be supposed that the richer crystals of these metals originated in the same manner. 15. In certain dendritic gems we observe formations like trees and groves, which are frequently tinged with some mineral fluid; the branches are sometimes sulphurated, sometimes silvered, &c., which apparently could only be caused by the agency of water. 16. In the same way, when the ores grow again in the veins after a lapse of years, it has been ascertained that the reproduction takes place in moist localities, or where the land is submerged; but as fire is contrary to water, so, in our opinion, the reproduction must rather be ascribed to the latter than the former. 17. We are enabled to strengthen this conclusion from certain lakes and rivers, in the beds of which the sand contains gold, silver, or iron; which again may be owing to the agency of water. Thus, *firstly*, at the bottom of some lakes, &c., both in Sweden and other parts, we find iron in almost a native state, which is annually taken away and rendered ductile: the bottom, thus frequently cleared of its ferruginous sand, nevertheless, after some time, is again enriched with the same, and in the same abundance as before. It is difficult to account for this, unless we suppose the ferruginous particles to exist in the waters, from which they fall to the bottom as a sediment, and yield a fresh crop every year. Certainly we cannot ascribe it to torrents or winds, since there are none such in these places to agitate the waters, or carry the sands thither. *Secondly*, we have some waters, and indeed whole lakes and rivers, full of sand containing copper, tin, and silver. How can we account for this, unless particles lurk in the water, which on meeting with a fitting matrix amongst the sands, take possession of it, and impregnate it with metal? A similar course of reasoning is applicable to the gold that is often found in river sand. 18. Experience also testifies, that mineral exhalations sometimes creep up through the roots and stems of certain trees and shrubs: thus, in some estates in Hungary, &c., grapes and vines are said to have been found that were impregnated with gold; the particles of which, in company with water, may have found their way into the inner channels of the growing vines, &c.

If, then, the native metals, which are every now and then found in the mines, be compared with the precipitates of the same metal, thrown down from menstrua, we shall observe the greatest similarity between the two classes of productions; and we shall see reason to conclude, that water serves as a vehicle to carry metallic effluvia and particles into their matrices. But should it be objected, that very dry veins are often found without a drop of moisture about the ore, and consequently that the presence of the ore cannot be due to the agency of water, we may reply that water creeps through the subtler pores imperceptibly, altogether differently from the way in which it permeates the larger passages. When the pores are small, the water rises up through them gradually, in such minute volumes, that it cannot be observed; in proof of which we may cite various species of stones, as marbles, stalactites, &c., which contain water in their substance. And we all know that water creeps up insensibly through ashes, through the filaments and ducts of plants, the layers of scissile stones, sponges, sugars, salts, tubes of very small bore, &c.; though where the passages are large, the water falls down them, and runs, in fact, in the opposite direction. Thus we may say that water runs downwards through the open and wide crevices or interstices in strata and rocks, and then creeps into the finer pores, or between the finer layers of the matrices.

But *secondly*, it may be objected, that in the mines we frequently meet with water of the purest quality, containing no traces either of sulphur, vitriol, or metal. Certainly this is not a very common occurrence, yet that it may happen we do not deny; but we suggest that whatever metallic matter it contained, may have been stopped on its passage, and the purer fluid only have escaped. We are now, however, treating only of the entrance of metallic particles into their matrices, not of the origin and generation of the particles themselves; this, therefore, is not the proper place for considering whether such particles are the produce of rays, or of a solar or central fire, or of some other cause.

Since, therefore, the above-mentioned waters are of such very different kinds, some being impregnated with sulphurs, others with mercury, and others again with salt or other particles adapted to this combination, and if we may form an opinion accordingly, we conjecture that such or such a metal grows or is composed by the meeting of these different waters. And perhaps posterity will discover some art, unknown to us, of making certain species of metals by the mixture of different waters impregnated with sulphurs, vitriols, &c. On the above principle it is, that in the same matrix and in the same stratum we frequently find four or five kinds of metals together, thus silver is frequently mixed with copper, lead, and gold; copper with zinc, bismuth, tin, cobalt, and marcasites of the most various kinds; which, in our opinion, may have derived their origin from the meeting of different waters, that brought with them the most simple particles of sulphur, salts, mercuries, &c., &c.

On Stalactites, and Crystallizations of Stone; with remarks upon the resemblance of these formations to Congealed Water.

We possess the clearest evidence that the dropping stone, or stalactite, is produced by the water dripping through the fissures and pores of stones; in proof of which, we need only quote the admirable phenomena of the Caverns of Baumann,* although many other caves of the same nature exist elsewhere. The roof and sides are full of stalactites resembling icicles and cylinders, the different forms being determined by the different obliquity of parts of the rock, and of the streamlets, as chance had caused the moisture from the slender crevices to flow into one or more places. In these observations, however, we intend merely to treat of the resemblance of these forms to water while freezing into ice.

There are two kinds of stones which appear to have derived their origin from this petrifying water; 1. Dropping stones, or stalactites, and 2. Stony Crystals. Both these kinds present nearly the same appearance and character as congealed water.

We find that the resemblance of the first kind, or stalactite, to water, is manifestly shewn, 1. In the external shape; the icicles hanging from any part of the roofs of houses, seem to be formed in the same manner. Thus they are extended in length; they are in part cylindrical; in part, owing to a slight obliquity, they are conical, lamellated, and uneven, or interspersed with tubules and swellings. This pendulous ice assumes the shape of tongues and other organs, with many different and curious forms that we admire in stalactites. The evident cause of these appearances lies in the origin of both substances from the dropping of water, for each of them receives its increase from the liquid proceeding towards the end, whilst its bulk is augmented by the variety of water flowing beneath. 2. On comparing the external form of these two substances more closely, we remark that the stone produced by the dripping water has channels and lines of various kinds, and planes intersecting each other at certain angles, and especially curving like a fringe; the same appearances may be observed in ice, for when either fluid falls obliquely, it cannot fail to become hardened here and there, and to generate a form agreeable to its motion, which is usually sinuous and serpentine. 3. If we inspect the internal arrangement and composition of the particles of stalactites, we observe that it is the same as in ice, though not in every kind; there is the same fracture, according to the same angles; the same brilliancy and sparkling appearance: this identity being necessarily produced by the aqueous origin of both substances. Thus we may suppose that in the stalactite, the position of the particles is the same as in congealed water; and in the latter nearly the same as in fluid water: there is a subtle matter, which in warm weather appears to lie in the interstices, and by its mobility prevents the particles from joining together; but when, by the loss of heat, it has either escaped or collected into globules, the same particles are bound into ice by their mutual contact; but the stalactites coalesce into a stony hardness by the agency of larger particles occupying the spaces of the aqueous. We think, therefore, that the difference consists in this circumstance, that in ice the spaces we have just mentioned are empty, but in the stalactite, they are filled by largish particles that fit the shape of the little volumes; whence it follows, (although not yet as a certainty,) that the arrangement, texture, and order of the particles are nearly the same in the ice as in the stalactite. But as we are treating of invisibles, we can only arrive at this conclusion by reasons drawn from analogy; if, however, this can afford assistance in unravelling the mysteries of nature, the conclusion must be considered as established in so far, until experience teach the contrary.

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* So called, because a person named Baumann was lost in them.—*(Tr.)*

As to the second kind of stone that is produced by a petrifying fluid or moisture, which gradually dropping produces stony crystals and other growths, forms, or vegetations; this kind, I say, has its exact analogue in ice; it differs however from the stalactite. 1. In exuding by degrees from rocks only and the hard substance of stones, as from the stalactite itself, from spar, quartz, &c.; and in growing out in various forms, as hexagons, triangles, pentagons, pyramids, and frequently into transverse lines. 2. It is generally produced in the smaller subterranean caves and hollows, especially were certain metallic effluvia are found; though here and there on the tops of mountains. 3. The particles of this second kind of stone appear evidently to have a different arrangement, which gives rise to pentagonal, hexagonal, and other angular forms, as may be seen in a variety of crystallizations. 4. Hence this second kind is distinguished from the first by fracturing triangularly, and in pyramidal, prismatic, and parallelogrammic forms; whilst the former fractures cubically and in square planes. The first kind is commonly termed quartz; the second, spar.

This latter sort of stone presents several points of resemblance to ice. Thus, 1. On ice, or on water once converted into ice, we find a number of shapes rising like vegetations, many of them fashioned by means of a certain moisture exuding from the hard ice. So we see similar kinds of germination about the stones described in the preceding pages; shewing that a fluid exudes or oozes in a similar way from both the hard ice and the rock, and imitates those vegetable forms that spring up from the soft ground. 2. On rocks, and in little crevices, fissures and caverns, we see hexagonal crystals springing up, nearly resembling those of nitre, vitriol, alum, precipitated metals, &c: the same appearance may be seen on ice, especially when the cold is very intense; of this germination we have spoken in Part III. of these *Miscellaneous Observations*, p. 82. At Gosslar also I noticed a peculiar crystal exactly of the figure delineated in the above account, viz., consisting of hexagonal plates upon a crystalline stalk. Moreover other forms may be seen on ice, which exhibit a parallelism with those belonging to crystals, as triangular, pyramidal, prismatic forms, &c. 3. Upon stones we frequently observe raised lines with tranverse ridges intersecting each other, such lines being produced by means of some fluid trickling from their interior; ice also, during intense cold, presents the same appearance, and the lines meet each other and cross in layers, and thus form the same shapes as exist in figured stones. 4. We see growths, like icicles, filaments and foliage, springing from the rocks; and parallel formations may be observed on ice; with many other productions referable to nature's play.

We have thus described two kinds of stone, which are considered to be formed by water or fluid; viz., the stalactite, and the crystalline. The former derives its origin from the water trickling through the crevices of mountains, which hardens in nearly the same manner as ordinary water congeals into ice: this sort of stone fractures for the most part cubically. But the second kind, the matter of which exudes and distils from the very pores and the hard mass of the same rock, in the same way as hexagonal and other figures are formed from the hard ice, generally breaks triangularly. Both kinds, therefore, arising as they do from an aqueous juice, although by a different process, exhibit a most striking analogy with the hardening of water into ice, which is all that I have at present attempted to shew.

On the Petrifying Fluid or Juice; with remarks to prove that it is not identical with the water that produces the stalactite.

The following particulars respecting the dropping water that converts substances into stone, are especially observable in Baumann's Caverns. 1. This water descends through the fissures and pores of the rock above it, which is of that kind usually designated horn-stone. 2. It is very limpid, like water from a fountain, or water containing a small quantity of common salt, which is generally more pellucid than water that is perfectly sweet. 3. It is perfectly sweet to the taste, but particularly cold. 4. To the touch, it is just like ordinary water, but being much impregnated with stony particles, it makes the skin dry and rough, as if it had been bathed with a solution of vitriol or alum. 5. As it drops from the roof or sides, and produces forms like icicles, the insides of the drops are at first void and empty, but afterwards are filled with water particles, and in the course of time grow hard. All these facts indicate, that the water, in penetrating the rock, becomes impregnated with stony particles, though not in such abundance as to occupy all its interstices, or to convert the whole volume into stone, but only to change that part which constitutes the crust of the drop; leaving in the interior a cavity until fresh stony particles are added, by means of which all the water in this cavity is in process of time converted into stone.

But to proceed to our subject, which is, to prove that the water that gives origin to the stalactite, is not the same as the water or juice which petrifies vegetables inclosed in stone or sand, as wood and leaves, and animals, such as fishes, quadrupeds, bones, &c. This is confirmed by what is observed in those places where stalactites are formed, especially in the celebrated caverns of Baumann, and in those of Schartzfeld, which contain a surprising quantity of bones of different animals, vertebræ, leg bones, teeth, &c., &c. Now though these bones have lain in this situation for a great number of years, the true character of bone still exists in all that remains of them, nor do they seem to be petrified in any part. Thus, 1. I observed some bones almost decayed, full of pores and perfectly spongy; nevertheless they still maintained their osseous character, nor did a single orifice or channel exhibit petrifaction, although I gathered several specimens, of many of which from these localities I am now in possession. 2. These caverns also contained some bones which still preserved their osseous nature, although they were inclosed in stalactites, and surrounded by stony matter on every side; as my specimens will demonstrate. 3. We may likewise observe a sort of earth in these caverns, which will not petrify, although surrounded with stalactite. From which we may conclude that the water that generates the stalactite is not the fluid which causes the stony hardness in soft bodies.

Besides, it is well known that in many places there are waters which have the natural property, not of petrifying, but only of incrusting substances. Branches of trees, foliage, leaves, herbs, and mosses may frequently be seen incrusted with stone, so that at the first glance they might be mistaken for petrifactions; although they really preserve their own natural softness within, and are merely covered with stone, like the bones mentioned above as inclosed in stalactite.

If, then, we may use conjectures and ideas, in conjunction with experience, to enable us to prosecute those subjects that are not obvious to the external senses, we may suppose that the petrifying juice is the fluid which oozes and exudes from the harder stones, such as spar, quartz, stalactite, &c.; or is the same fluid that converts soft substances into rock or stone, and otherwise forms into crystals. Our reason is, that this fluid is much more subtle than the dropping water already mentioned as producing the stalactite, and the stony particles contained in it are smaller and subtler than those existing in the latter; in the same way as when salt water is subjected to distillation, the larger saline particles are broken into smaller ones, that is, into acids, which in this state appear to exert quite a different effect from that of the salts when larger and entire.*

In the preceding pages we have in some measure pointed out, that one description of stone is produced by the dropping water, and another kind by the fluid oozing from the pores of the stones; by means of the latter, crystals and figures as of plants are formed. The first kind of stone generally assumes cubic shapes, but the second prefers the pyramidal and triangular; like salts, which, if entire, crystallize cubically in water, but if broken, they crystallize triangularly. Hence we may with some confidence assert, that the subtler fluid of the latter kind is the agent which converts soft bodies into stone, or has the petrifying property; and this view is confirmed by the circumstance, that the petrification of soft substances generally takes place in closed places, where the surrounding stone is comparatively hard, as well as in those very localities where crystals are produced. I am in possession of some of these petrifactions, and I have seen shells covered on every side with crystal, their valves consisting only of a crystalline and pellucid substance.

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* On this subject see the author's Theories of Salt and Acid in his *Chemical Specimens*, p. 55, 67.—*(Tr.)*

On the formation of Quartz and Spar; with reasons shewing the probability of their post-diluvian origin.

No kinds of stone require a more careful examination than spar and quartz; for the ores of all kinds of metals are generally enclosed in them. We find that they are commonly impregnated with gold, silver, copper, tin, lead, sulphur, &c.; while the neigbouring strata, being of another kind, are free from these substances, and incapable of receiving ores or minerals. As, therefore, these two sorts of stone are generally the matrices of ores, and as some of their varieties are used as fluxes in smelting furnaces, we consider it of the utmost importance to investigate their nature. In this place, however, we shall only treat of their origin, which we are not inclined to attribute at all to clay, soil, or any other matter existing before or during the Deluge, but solely to water and petrifying juices at subsequent periods. There are many probable arguments in support of this view, by which, if they seem to be of weight, we shall afterwards be enabled to arrive at some more certain conclusion respecting the texture and character of the particles of these kinds of stone. Thus, 1. We find that the fissures and crevices of mountains are usually filled with these kinds of stone; wherever the rock is seen to have opened, or to have been cracked in former times, it may be observed that spar or quartz have agglutinated the fractured parts; indicating that in process of time, some petrifying water or juice has occupied these vacant spaces, and filled them with these peculiar stones. 2. A similar result may be remarked in small strata; very slender veins, or thin intermediate layers, are frequently seen between the layers of scissile stones; these veins consist of spar and quartz, and appear to have bound the other layers together into rock, frequently of very great hardness; in consequence of this infiltration, we can hardly meet with any strata or layers of this kind of scissile stone, as at present it only lies in a sort of contiguous arrangement. 3. In the mines we not only find whole strata filled with this description of stone, but irregular spaces also, which sometimes are shaped like cones, sometimes like round cavities; occasionally they represent clefts or caverns of various dimensions, as would be distinctly perceptible, if they were empty. These places are called kernels and nests, because they are generally found to contain ore, which however does not continue beyond the farther extremity of the cavern or mass. Nor indeed does any view seem more consonant to reason, than the opinion that these spaces were at first empty, but in process of time have been filled up by means of some fluid or juice exuding from the rock. Experience also is in our favour. Thus we meet with caverns of this kind, like Baumann's and many others, still empty under the mountains, and frequently extending for several miles, and very irregularly shaped throughout. In time, these caverns are filled with stalactites, which gradually block them up; and thus at the present day we have the very process going on before our eyes, which we find accomplished in the mines. 4. It appears that the same conclusion may be drawn from the resemblance of the stalactite to spar, and of the crystallized stones to quartz; we observe the same texture in the stalactite as in the spar, the only difference being that the latter breaks into wider planes and larger cubes than the former. If we enquire the cause of this difference, we see clearly enough that the stalactite might be divided into planes of the same magnitude, if the fluid divisor had but penetrated between the planes, and made the same stone capable of division into larger cubes. The same remark applies to quartz. 5. This may be confirmed by what we know of spar supporting the most intense fire; a quality possessed by stalactites also; by the fracture in both substances taking places in cubes; by their likewise agreeing in colour, unless the spar be impregnated by a mineral water. Thus stalactite seems to be converted into spar by some mineral or saline water having permeated its layers, and run between its planes. Hence, also, I have remarked in many mines, that the stalactite stone occupied an entire stratum or cavern, and a vein enriched with some kind of mineral passed through the middle of it; next to which was spar, of a different colour and weight, but there was nothing near the spar or around it but stalactite: this subject, however, will be better entertained hereafter. 6. Our theory is also supported by the fact, that crystals still grow in a thousand small orifices, and gradually take possession of the vacant space by continually uniting, and thus produce a peculiar quartz, which has a triangular fracture. As we observe these changes taking place at the present day, the points of agreement afford us grounds for thinking, although not for positively asserting, that all these kinds of stone have been formed since the time of the Deluge.

Still more to strengthen this opinion, we might quote the evidence afforded by a thousand other places and mines; we shall however only mention the copper mine in Lauterberg, called *Kupperros,* which is an excellent example. Should any one wish to explore this mine, and examine its ore thoroughly in the stratum, he will plainly see the agreement with our hypothesis of all those facts which we have adduced in its support. He will there see, 1. A stratum of considerable size, descending from the surface of the mountain to its lower parts, and exhibiting various swellings and enlargements on the way: thus in some places it dilates to twenty or thirty ells in width, whilst in others it is contracted to three or four, and then again swells out. 2. At a depth of about one hundred and eighty ells, this stratum consists altogether of sand, in which, however, a vein of copper is concealed, but the colours vary in different ways; so that this metallic vein appears to have slipped down into the sand together with the upper part of the stratum. 3. Nearer the bottom, this stratum becomes harder, and stony; and the hardness increases with the depth; but it still occasionally expands and contracts as before, always continuing to sink lower. 4. On examining the sort of stone of which this stratum consists, it is found to be neither spar nor quartz, but an intermediate species evidently stalactitic, being very white, of the same grain as stalactite, of the same weight, and possessing the same properties under the action of fire: the workmen themselves assert the same fact. 5. In some places stalactites are formed which closely resemble in their structure or constitution the stone of the stratum wherein they are. 6. The richest copper vein passes through a stratum of this stone, and cuts it in two; the next layer to the copper vein is spar, a white stone fracturing into large cubes, and more compact and heavy than stalactite, &c.

Here we find our opinion vastly strengthened. 1. It is a true stalactite that occupies the entire stratum to a thickness and depth of so many ells: at this very day it is reproduced, and its nature is not denied by any of the workmen in the place who know anything about the matter. 2. When we consider the extent and varying form of this stratum, we recognize most distinctly the empty caverns which in process of time have been filled up by stalactite: there are the same bulgings and enlargements, exactly as in the Baumann, Schartzfeld, and other caverns, through which the vein of copper ore has made a passage for itself. 3. What is the spar here but the offspring of the stalactite? with the addition of hardness and increased gravity. 4. How is it that this stratum with the ore on its upper part has been softened into sand, whilst the lower portion still remains hard and rocky? How, but because the same stone has crumbled into sand under the action of some kind of watery fluid? The same kind of stone is recognized in sand; the same kind of ore is converted into sand; and moreover, we see a part softened into sand by the simple accession of water: which process of softening I have already noticed in another place in these *Miscellaneous Observations*, p. 44, 48. I need not mention the numerous instances afforded by other mines, since the example we have selected surpasses all the rest; I can only refer the incredulous to Baumann's Caverns, and to the copper mine in Lauterberg; to the former as shewing very similar spaces, which are being filled in the lapse of ages; to the latter as containing the same spaces, but filled up already.

But should any of my readers be desirous of pursuing the subject, and of enquiring into the cause of these and similar strata and caverns that in time are filled with stones by the medium of a watery fluid, this, we beg to inform him, is not the place for such an exercise. Nevertheless, as numerous causes may be given, I will mention a few of them. It is very clear that the first matter of mountains was soft and argillaceous; we might expect, therefore, that when it hardened into stone, 1. A mountain would have crevices in various parts, forming intervals and vacant spaces. 2. Nor does it seem possible to deny, that when an argillaceous mountain was violently brought together into one mass, water might be enclosed in many places, and hollows or caverns be formed accordingly. 3. In some parts, torrents of water arising from small beginnings, might penetrate through the softer rocks of the kind, and gradually excavate considerable hollows. 4. Mountains may likewise have subsided and been swallowed up; perhaps also they may have vomited fire. Such we imagine to be the origin of the caverns and strata afterwards filled by this stony matter. But as we are not professing to speak on this subject, we merely allude to it briefly, leaving the rest to be supplied by the learned reader.

General observations on Furnaces for smelting Iron, with suggestions for improving them.

As nothing is of greater antiquity or utility, both in its experimental and theoretical aspects, than the art of smelting metals, so I believe there is nothing of which it is more difficult to acquire a knowledge. The practical experience is generally confined to the unlettered and rude portion of the smelters, who preserve and daily use the rules handed down to them by their masters, parents, or others, but do not attempt to examine them more profoundly, or to propose to themselves the accurate knowledge and amelioration of their fires, metals and furnaces, because they are unacquainted with the true principles, and because each man considers his own knowledge the best. As to the theory or more intimate consideration of these matters, there are several highly competent and sagacious enquirers who have entered upon it; but being destitute of the practical information, they do not appear to have the required foundations on which their ingenious minds and acute reflections should rest.

This is the reason of the great discrepancy which exists at present between the different modes of treating metals; of the employment of so many different furnaces for the same ore; of so many varieties in the hearths and fires in which the metal is reduced; and of the numerous ways in which the fire itself is applied. Now, although the investigation of all these subjects is an undertaking beyond my powers, it may nevertheless be right and proper to bring forward those points touching the furnaces used in smelting iron, which are dictated by experience, and those which are dictated by first principles; in order that others may afterwards supply what is deficient by a just combination of talent with opportunity and experience, and that at length we may elicit principles on which the improvement of iron furnaces may be based.

To arrive at the true method of treating a given ore, the following circumstances must be carefully considered. 1. The nature of the ore, its composition, what proportions of stone, sulphur, and metal it contains, the effects produced upon it by fire, &c. 2. The proper construction of the furnaces as to form, height, capacity, and other necessary points required for the ore. 3. We must not omit the fire-hearth or focus in which the ore is liquefied, and which is as it were the spring and life of smelting operations. 4. The blast likewise must be proportioned to the ore and furnaces. 5. And it is of the highest importance that the quality and proportion of the fire be considered with respect to the furnaces, fuel, ores, &c. Unless due regard be paid to these five points, and unless both experience and theory confirm the result, I believe that all our labour will be in vain, and any success ascribable to fortune alone.

In this place we intend to treat only of iron, and iron furnaces: but we shall first give general rules and observations as to the fire, the furnace, and the manner of reduction.

Iron ore is of different kinds; thus it may be, 1. Pure and genuine. 2. Poor in metal. 3. Rich in metal. 4. Mixed with stone, which may melt either easily, or not, at the same heat as the ore. 5. Or it may be impregnated with sulphur. 6. Or with different kinds of metals. All these circumstances must be duly considered, if we wish to obtain the true shape in the furnace, and the proper effect in the fire.

As to the furnaces, I shall instance a Swedish specimen, in order that our rules may be stated by examples, and not as theory alone. This furnace agrees in every respect with the figures and description in my *New Observations and Discoveries respecting Iron and Fire, and particularly respecting the elemental nature of Fire: together with a new construction of Stoves*:* it is very lofty, bellies out in the middle, is narrower below than above, and in short, exactly answers to the dimensions given in that work.

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* *Some Specimens of a Work on the Principles of Chemistry, with other Treatises*, p. 181. 1847.

The most general rules. When the ore falls amongst the charcoal in the cavity of this furnace. 1. In the upper part, it is calcined and freed from the superfluous and dense sulphur, or from its more volatile part, if any be present. 2. The ore is liquefied and melted in the middle, where the furnace widens to form the belly, and consequently the heat is most intense. 3. In the lower part, through which the ore runs in drops, it is separated from its scoriæ and stony accompaniments. 4. In the focus, the separation is more thoroughly effected by means of the motion and blast, whereby the lighter parts remain on the surface, while the heavier sink to the bottom. Such are the more general rules; although we might cite a hundred other special directions, some of which will be seen in the following pages.

I. If the belly be too spacious and ample, or exceeds the given proportion, then, 1. The ore will be dissolved too suddenly and violently, and be broken up rather than melted. For if the belly surpass its proper dimensions, the fire will be too intense, because it increases with the space; hence a disruption of the particles will take place rather than a complete resolution. This violent action gives rise to the following results: 2. A part of the ore will be vitrified, or converted into scoriæ with the stony part. 3. Its sulphureous parts, if still present, will intimately mingle with and adulterate the iron. 4. Thus the quantity of iron will be diminished, and the remainder will not be of the desired good quality, because a wrong disposition of its particles will ensue. I need hardly mention that the belly will, nevertheless, dilate spontaneously by the continued fusion.

II. If the furnace has no belly in its middle part, but expands towards the bottom to form a cone, as in several of the German furnaces, then the following results take place. 1. The ore certainly is properly calcined, and freed from the more volatile and sulphureous matter; provided, that is to say, the furnace be lofty, and the cone not very oblique. 2. But it cannot be so effectually separated from its stony part; for unless the melted ore falls down dividedly and by drops into the fire, and has sufficient space to run in the furnace when the liquefaction is completed, the foreign substances remain; and in the focus, when present in large volumes, they cannot possibly be removed. 3. Hence the iron is deteriorated, and is not of good quality. 4. Moreover, owing to this enlargement, the blast is too soon dispersed, and is driven upwards, with a loss of fuel, from the focus where it ought to produce its effect: unless these evils be guarded against by narrowing the aperture, as I have sometimes seen done.

III. If the belly be above the middle half, then, 1. The ore will not be so completely calcined, and purified from the sulphur and volatile substances. 2. It will liquefy too soon and carry the sulphur with it into the focus, where it is impossible afterwards to separate it. Hence the kind of iron produced will contain sulphur, and be brittle when hot, and tenacious when cold. 3. This form of furnace also allows the larger fire existing in the upper part to consume a great quantity of charcoal.

IV. If the upper part of the furnace be too broad and open, then, 1. The ore is suddenly exposed to too violent a heat, and melted before its sulphureous part has escaped. 2. And the charcoal is burnt away without producing the proper effect on the ore, whereby a double loss is sustained.

V. If the sides of the furnace be square instead of round, then, 1. The effect of the fire on the ore and charcoal varies; there is a different degree of heat in the angles and adjacent parts, to that at the sides nearer the centre. 2. More fire penetrates into one part of the wall than into another. 3. The inequality of the fusion occasions an irregularity in the quality of the metal. 4. And more charcoal is consumed in the square furnaces than in the round, owing to this inequality of the heat diffused through the ore and the fuel.

VI. If the furnace be too low, 1. The effect of calcination is immediately lost. 2. And if the sulphur is not driven off, the stony matters are not properly separated. 3. There is also too little heat in the focus. 4. And the blast escapes too quickly, and consumes a disproportionate quantity of fuel.

VII. If the furnace be very lofty, 1. There is more heat in the focus. 2. The blast produces a better effect. 3. The charcoal is expended more rapidly, but a greater weight of ore may be thrown in, or, which comes to the same thing, the usual charge may be introduced more frequently. 4. It appears, therefore, that a smaller quantity of fuel is burnt with a better effect. 5. At the same time the superfluous sulphur is properly expelled, and thus the stone is prepared for the separation of the scoriæ and for fusion.

VIII. If the furnace be wider than the due proportion, both in the upper and lower parts, that is, if it be more capacious, then, 1. The degree of fire is too great to allow the first heating and calcination of the ore to be duly performed. 2. The ore is dissolved and melted too rapidly in the upper part, and too violently in the lower; whereby the iron is contaminated both with the sulphur and the stony matter. 3. The consumption of charcoal is also greater than necessary. 4. And a smaller quantity of iron is procured, because a part of it is converted into glass and dross.

IX. If the furnace be parallel from the top to the bottom, 1. The fusion is not completed in the proper time. 2. The ore is first melted in the focus, in consequence of which its impurities cannot be separated. 3. Besides, to be completely and intimately dissolved, iron requires a most intense heat, which it ought to receive in the proper place, if we wish to avoid waste of fuel and loss of metal.

X. If the lower part of the furnace or focus, called in Sweden the *stelle*, be too ample, 1. The blast cannot penetrate to the opposite side, or circulate as it ought; nor can it set the fluid mass in motion, and separate the scoriæ from the metal. 2. But before the blast has reached the centre, it is dispersed upwards, the surface of the charcoal is blown off, and the fuel is spoiled, without the due effect being produced on the ore; for the blast ought to proceed round the sides, and ascend from them, but not to rise up in the middle. 3. Besides, there is too great a heat above the focus, which violently loosens the particles, and produces the prejudicial effect mentioned in the preceding pages. For the particles may be very easily broken by too much heat in the focus, when the ore flows down dividedly in drops; hence skilful smelters observe most carefully, through the orifice for the bellows, the colour and pellucidity of the drops as they are running downwards.

XI. If the focus or *stelle* be longer than it should be, but at the same time narrower, as it frequently is in the German furnaces, the following results are occasioned. 1. The iron which is melted does not afterwards receive a sufficiently powerful fire, owing to the extensive sides in this shape, which greatly moderate and diminish the intensity of the fire. 2. The fluid mass cannot be agitated by the blast, for the perfect separation of the scoriæ, owing both to the figure of the focus, and also to the greater coolness of the metal. 3. If above this focus, the furnace be of ample dimensions, as in several of the German smelting works, the melted ore retains its stony components most tenaciously, and the iron is of a bad quality. 4. The ore cannot be rendered fluid unless by adding a large quantity of menstruum or flux, *i.e.*, of a lime stone, called *kurim* in many localities; but this measure is attended by an increased expenditure of charcoal, and loss of iron. 5. But the chief objection is, that a smaller charge of ore must be introduced, amounting to scarcely a half or a third of the quantity which might be melted if the focus were of a different form and proportion. 6. Besides, the plate of the orifice for the bellows cannot be placed obliquely, for on the least inclination the mass immediately cools; and consequently, owing to its horizontal direction, the blast is carried into the middle of the furnace, and the fuel is burnt away to no purpose.

XII. If this focus be too narrow, it gives rise to the same inconveniences; a great quantity of the flux or *kurim* is required for the fusion of the ore and the separation of the impurities: consequently there is a useless consumption of charcoal without any improvement in the iron; and the hourly charge of ore cannot be introduced in the proper proportion.

XIII. If the stones or sides of the fire-hearth be too thick, certain disadvantages ensue. Thus, 1, the iron cools and adheres to the sides, so that a large quantity of flux must be melted with it. 2. A comparatively small charge of ore must be introduced, especially when there is a double row of these stones, as in the German furnaces.

XIV. If the bottom of the focus be damp, or the stones have not been thoroughly dried, or the passage beneath is improperly constructed, &c., the same disadvantages are to be apprehended; the fuel is unprofitably and uselessly spent, a large quantity of calcareous stone must be added, whereby the quality of the iron is deteriorated; not to mention that less than half the usual charge of ore must be introduced.

XV. If the blast be not duly proportioned to the dimensions of the furnace and fire-hearth, the smelting is injured. For, 1. The mass of liquefied iron is not moved as it should be. 2. The scoriæ are not separated from the metal. 3. Nor is there a sufficient supply of air to the combustible matter; there is, therefore, a want of fire in the charcoal, and consequently, of effect on the ore, which must be compensated by an increased quantity of fuel.

XVI. If the passage or orifice for the blast be too horizontal, 1. The mass of iron is not set in motion by the air. 2. The blast is immediately carried away to the upper parts, but is not diffused towards every side, so as to exert an equal action on the charcoal; the latter, therefore, is consumed, without the ore being properly melted. 3. When, however, the focus or *stelle* is longer and narrower, this orifice ought to be horizontal; if oblique, the mass of iron might cool; which must be guarded against by the combustion of an undue proportion of charcoal.

XVII. If the position of the orifice for the blast be too oblique, the melted ore cools round the opening of the bellows; the cold air passing to the middle of the mass, which it cools and frequently hollows out, as experience demonstrates. This is often seen under the opening, a cold hollow being formed in the middle of the metal.

XVIII. If the due proportion of fuel and ore be not observed, thus if too much charcoal be introduced, then, 1. The iron may be vitrified, and partially converted into scoriæ: and the mass will appear glassy, silvery, and sparkling; also very brittle, and lighter than otherwise; in short, of the worst quality. 2. To say nothing of the useless consumption of charcoal. Thus the proper quantities must be ascertained by particular signs.

XIX. But if there be more ore than charcoal, 1. The iron will indeed be duly calcined, yet not smelted. 2. The stony part will remain, and some of the ore will pass in a crude state into the focus. 3. Hence the metallic mass will be glittering and brittle. 4. It is also to be feared that the volume of iron will harden on account of the low heat, and the melting be brought to a stand. Nevertheless, it is sometimes necessary to obtain iron of a harder quality, less roasted, &c., as for certain cast articles, anvils, &c., which are usually manufactured with a smaller quantity of fuel.

XX. If the different ores be not justly porportioned, especially when many kinds are used, several inconveniences will arise. For it is important to adapt the furnace to the ore; and this, both in height and width, in the shape of the focus, in the proportioning and distribution of the blast, and of the orifice. But when many sorts of ore are to be melted, they may all be treated in the same furnace by mixing them together and calcining them in various proportions.

In order, therefore, to accomplish the smelting of iron satisfactorily, and to obtain metal of the best quality, with the smallest expenditure of fuel, the following points are necessary to be observed. 1. The furnace should be of the proper shape, as well as the focus or fire-hearth; and the orifice of the blast should be fitly placed. 2. The smelter should be skilful, as otherwise he may succeed but indifferently, even with the best of furnaces. 3. The proper mixtures of the various kinds of ores should be well ascertained. 4. Afterwards, in the furnace where the iron is re-melted and rendered malleable, all the processes should be skilfully performed. By observing these essentials, we cannot fail to obtain a superior description of iron, with a comparatively small consumption of charcoal.

Since, therefore, it is in the nature of iron to bear the hottest fire, yet when melted to be easily vitrified, and at the same time converted into scoriæ, also to mix with stone, as well as with sulphur and certain metals; and since it is consumed by sulphur, and flies away with it in fumes, therefore we must not only know all these points, but also apply them; 1. In the true construction of the furnace. 2. In calculating the proportions of the lower fire-hearth and blast. 3. The calcination of the different kinds of ore. 4. The proportions for mixing the same. 5. The right times and places for introducing charges of the proper weight. 6. The relative quantities of the fuel and ore; and many other circumstances, which none but skilful smelters can know. And although each kind of iron ore requires a peculiar treatment, and appropriate furnaces, fire-hearths, and blasts, yet art can effect much in enabling any or all of them together to be properly reduced in one and the same furnace.

Such are the general rules and observations respecting iron and the furnaces in which it is smelted. Guided by them, I will now describe a new kind of furnace, which I think will be best adapted for fusing the different kinds of iron ores. 1. It should be round, like the furnaces generally used in Sweden, and of the same dimensions, both above and below; thus the diameter of the mouth may be three ells; of the belly, four ells; and of the lower portion, two ells and a third, which are nearly the measurements of the common Swedish furnaces. 2. But it should be two or three ells higher than them. 3. The sides of the upper portion should be almost parallel. 4. In proportion as this furnace is more lofty than that in ordinary use, the belly may be placed lower down, so as to be in the middle of the furnace, supposing it to be of the common height and construction. 5. The focus beneath should be built of bricks made of French clay, as it is called, which has the property of resisting the action of the fire; this clay is found in many parts of Germany, as well as in France. 6. The shape of the focus must be oval, somewhat broader above than below. 7. Underneath it there should be an arch built of the same kind of bricks, as they cannot be injured by the violence of the fire. 8. A passage is to be made from one side of the furnace to the other, for the heat to escape. 9. Under these, there is a plate of iron, beneath which again there is a passage for the evaporation of water. 10. If the sides of the furnace be protected with the above-mentioned bricks, the fierceness of the heat will be prevented from damaging the walls. 11. The bellows should be heavy, and they ought to be placed as nearly as possible to the smaller diameter of the oval or ellipse formed by the focus.

The following advantages result from these arrangements. 1. The ore is thoroughly calcined from its sulphureous parts before it arrives at the blast. 2. The fusion or melting takes place near the belly, exactly in the same way as in the common Swedish furnaces, but with greater profit, as the ore is purified from sulphur. 3. And it is freed also from its stony part below. 4. The elliptic fire-hearths afford a more intense heat than those in ordinary use; they have a less extensive cooling surface; they contain more space within the same lateral dimensions, especially when they are broad above, and shaped like a truncated cone. 5. The blast likewise appears to be more completely diffused around the surface of the iron, and at length to rush upwards at the sides of the furnace. 9. The foundation of the fire-hearth, or the arch underneath it, built of the same kind of bricks, makes the mass of liquid iron in the focus still more intensely hot. 7. The weight of the bellows also assists in producing this result.

Thus, as the grand difficulty lies in such a construction of the focus, that the ore shall run into it in a proper manner, and be supplied with a degree of heat sufficient for its fusion, so when our construction is perfect, the following results ensue. 1. A larger quantity of ore may be introduced in the same time; solely owing to the shape and heat of the fire-hearth, as is well known to the Swedish smelters. 2. There is no necessity for so much flux or calcareous stone, (*kurim*, as it is called,) as is indispensably requisite in the narrower and cooler furnaces. 3. The blast can be augmented to any degree that may be necessary, as the argillaceous stone or brick resists the energy of the hottest fire: not to mention other points, which must be previously confirmed by experience.*

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* In the *Observations respecting Iron and Fire* (p. 183), the smelting furnace was said to be capable of holding about two hundred tons of charcoal: the Swedish ton there mentioned is the *Skeppund*, which is equal to about four hundred English pounds.—(*Tr.*)

END OF THE MISC. OBS.

APPENDIX.

PAPERS BY SWEDENBORG

FROM THE

ACTA LITERARIA SVECIÆ.

APPENDIX.

PAPERS BY SWEDENBORG FROM THE ACTA LITERARIA SVECIÆ.*

Letter to Jacob a Melle.

Most learned Sir,—

I HAVE lately received the description, which you had the goodness to send me, of the figured stones found in the environs of Lubeck: and I am rejoiced to find that the researches of the learned are everywhere bringing to light at the present day so many indubitable evidences of the existence of the primeval ocean. Many parts of Sweden abound in figured stones, and in various kinds of petrifactions, of which the Provincial Physician, Dr. John Hessel, formed an excellent collection in West Gothland. Our most distinguished collectors of these objects are, Dr. Magnus Bromell, Assessor of the Royal College of the Mines, who some time ago had many figured stones and other petrifactions engraved on copper; and Dr. Lawrence Roberg, Professor of Medicine in the University of Upsala. To their labours and to yours we are indebted for some remarkable attestations of the depth of the primeval ocean.

That the land on which we now dwell was formerly the bed of a sea, is clearly shewn by these and many other circumstances. On a high hill, not far from the city of Uddevalla, there is an entire tract of land consisting of different kinds of shells and of tortoises: a similar formation exists near Strömstadt, in a still more lofty hill, seventy ells above the level of the sea, and also in the islands of Tiorn and Oroust. These remains are so abundant, that the inhabitants burn them, and thus obtain a most excellent lime, which they sell throughout the district. It would be well worth while to engrave the several species of these tortoises, as they are exceedingly numerous.

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* Two of these papers were translated into English in the *Acta Germanica*, vol. i.; London, 1742: this letter, at pp. 66—68, and the following one, on Heat, at pp. 122—124.—*(Tr.)*

Strata of the most various kinds may be observed in Sweden; as, for example, in the mines throughout the country, and especially in one in the province of Schonen, not far from the city of Landscrona: they may also be studied in the shattered remains of several hills, and in the slopes of the highest mountains, as Kinnekulla, Billingen, &c.

That the ocean formerly stood at a considerable elevation above our soil, is more conclusively shewn by the appearance of the earth towards the north, than by that of the countries farther to the south. In our own country, whole provinces are filled with stones of immense size and weight, scattered over their surface; and these masses are larger and more numerous, as the district is at a greater height above the level of the sea. In a treatise, written in Swedish,* which you have deigned to quote in your remarks, I have endeavoured to shew that at the bottom of a deep and rolling sea, stones of vast weight may have been carried about and transported over the globe; that this was the fact, may be deduced from the following hydrostatic grounds. 1. Stone, compared to its bulk of water, does not weigh more than 2½ to 1; and to salt water, still less. 2. Consequently, in the water nearly half its weight is lost; and instead of 2½, only 1½ remains. 3. Hence the weight of the stone is not so perceptible in the sea as in the air, for the aqueous element is so heavy, that it is nearly equal to the remaining weight of the stone; that is to say, if the stone, whilst in water, weighs to water as 1½ to 1, it will, whilst in air, weigh to air as 2,000 to 1, at least. 4. Therefore, if the waves act on the sea at its bottom, as storms drive the atmosphere at its bottom, where we dwell, and if the column of the sea be several hundred fathoms deep, the impulsive force of the water fluctuating at the bottom will certainly be increased in the ratio of its depth and base; consequently, a sea wave continued towards the bottom has more power, owing to its depth, than the same wave on the surface. 5. The primeval ocean, therefore, must have been able to tear away rocks of enormous bulk from the hills, to carry them along in its course, and to strew them over the soil in various directions; also to disturb the whole of its own bed. 6. These changes it effected in the same way as the atmosphere acts at its bottom on sand, wood, bark, leaves, feathers, rags, and many other such substances: for when the air is set in motion by a tempest, these bodies are caught up and carried aloft, as though they were really lighter than itself. This appears to be partly owing to the height of the atmosphere, which, when set in motion by the weight of its own column, imparts a power to the storm, like that of a large body in motion. 7. Many examples of this principle are afforded by embankments, or water dykes, formed by a double planking, filled with heaps of stones: thus, whenever the water rises three or four ells, which generally happens in the spring, it has sufficient power to overthrow the dyke, and carry away the stones sometimes to a distance of above a hundred yards. This is owing to the height of the water. Hence, in places in Sweden at a great elevation from the sea, as in the district of Orebro, which is between the two seas, the fragments of rock are larger and more numerous than elsewhere; for they could be conveyed thither by the following waves, but not higher, because they would be nearer the surface.

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* *Om Wattnens Hoegd, och foerra Werldens starka Ebb och Flod, Bewis utur Swerige.* 8vo. Stockholm, 1719. Arguments derived from appearances in Sweden in favour of the depth of the waters, and greater tides of the sea in the ancient world.—(*Tr.*)

From these facts we may infer that the inequalities in the surface of our present soil were caused by this ocean; and that all the uneven formations of mud, shells, sand, and stones, were produced by the waters fluctuating at its bottom. Hence would arise, 1. So many hills of different kinds and shapes. 2. So many strata in them. 3. Many mountainous ridges, stretching for eight or ten miles, and consisting partly of sand, partly of pebbles, and partly of large rocks. 4. A roundness in the very pebbles of which these vast ridges are composed;

for they are as if polished in a lathe, a sign that they have been driven about and rubbed against each other by a constant rolling motion at the bottom of the sea. 5. These views are greatly strengthened by the fact, that the backs of these ridges of hills in Sweden generally run from north to south; this appears to have been occasioned by the constant easterly and westerly winds, like those which prevail at this day in the great ocean: for such winds must necessarily have existed in the diluvian northern ocean, as there was no shore, &c.

These circumstances might have taken place in a deluge; but it may perhaps be doubted whether they all happened during the Deluge of Noah, which lasted only one year. For in many places which are, at present, forty or fifty ells above the level of our sea, the timbers and ribs of large vessels are yet found; and in the very mountains there are hooks, rings, mooring places, and many other signs proving that the ancient inhabitants possessed a port in that spot; and it is certain that towards the north the level of the Baltic is still gradually subsiding at the rate of four or five ells in depth within seventy years. Hence many places are now under the plough, which once were navigable for shipping; and crops are raised where fish were formerly taken. I have myself seen these marine places, and have heard old people speaking of them. In Western Bothnia, within a single century, there are towns that have been in this way removed from the shore, and their ports are now several hundred, or even a thousand yards distant from their ancient localities: of which, the city of Upsala and several others may be quoted as examples. These facts tend to shew, that all such changes did not take place in the universal Deluge; but that for a long time afterwards, the lands, towards the north in particular, were buried under a deep ocean, whence they gradually emerged as the sea subsided towards the north; or, in other words, its bed became habitable. If this view should derive additional confirmation from other discoveries, similar to your researches in the vicinity of Lubeck, we shall have grounds for believing, though not yet for asserting, that, 1. The horizontal pressure of our world is liable to change; which necessarily follows, if the seas are depressed towards the poles, and raised, as reported, towards the equator. 2. Consequently the distances of latitude vary. 3. Certain lands, at present continents, may formerly have been islands, which have united in course of time as the sea subsided. There are many other points, which I do not venture to publish until I am furnished with additional proofs, and thus enabled to proceed on a firmer foundation.

In the meantime, it is pleasant to investigate the causes of things, and to listen to those who have the genius to penetrate into the secrets of nature, and the industry and strength to evolve the ancient from the modern world. Amongst these enquirers, most learned Sir, I include yourself, and most sincerely do I trust that you may long live to confer benefits upon science.

Stockholm, May 21, 1721.*

New Rules for maintaining Heat in Rooms.†

In the northern countries the method of preserving the warmth of rooms is entirely different from that in use in countries nearer the south. In the former, close stoves are employed, whereby the heat retained in the burnt wood and charcoal enters the apartment, and fills it with warmth, which lasts for the whole day. In the latter, a different plan is adopted. But I will now mention the rules by which the heat may be maintained in rooms where the stove is closed by plates, &c.

I. Rooms constructed of timber are warmer than those built of stone; that is to say, wooden walls supply a greater heat than those of stone. This is owing to stones incessantly emitting a certain degree of cold, which diminishes the heat near the walls. Consequently, a room will feel cold in proportion as it has a large surface of stone wall, but warm when it has a surface of timber. To confirm this fact by experiments, place a large stone in the fire-place, and you will find that the fire immediately loses much of its power, because cold exhales from the stone. A sensation of cold is always experienced near any large stone. Walk on a stone pavement, and in a short time you will feel in the soles of your feet a sensation of cold, which will soon affect the whole of your body. Sit upon a stone, and in less than a quarter of an hour you will feel great cold. Place a block of ice in a room, either in a corner, or under the table, and you will feel a great degree of cold exhaling from it, and indeed to a considerable distance; this exhalation is according to the size of the ice.

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* Extracted from the *Acta Literaria Sveciæ*, vol. i., anno 1721, pp. 192—196.

† From an original letter, in the *Acta Literaria Sveciæ*, vol. i., anno 1721, pp. 282—285.—*(Tr.)*

In like manner, the more wood enters into the construction of the room, the warmer it is. Thus, if the walls, tables, chairs, and other furniture be made of wood, they radiate neither cold nor heat; but when their heat is in the least increased, they immediately diffuse a very gentle warmth, which lasts for a long time.

If the stone walls are lined with wainscot or hung with tapestry, a greater degree of warmth can be maintained in the same apartment than if the walls are bare; for the lining prevents the cold from striking so far from the stone, and diluting the heat in its neighbourhood. Hence, by these means, the heat may be greatly preserved.

Also, if the stone walls are covered with a thick coat of plaster, for the plaster does not exhale so much cold as the bare stone; hence it not only absorbs the cold, but prevents it from entering the room.

Walls built with the common grey stone emit more cold than others: and this, in proportion to the size of the stones, or the thickness of the walls; as is very perceptible in churches. Brick walls emit less cold.

When the stone is porous and light, it emits less cold, and receives heat with greater facility; such is the case with the scoriæ of iron and lime. In like manner, wood preserves heat in proportion as it is porous and impregnated with sulphur.

II. Thin walls of stone contain and preserve the heat in a room better than thick ones. This assertion seems contrary to principles in the opinion of many, who think that the thicker the stone wall, the better is it adapted for keeping the external cold from penetrating through its crevices. But they do not consider that an intense cold exhales from the stones themselves, and this in proportion to their thickness; for it is scarcely possible to heat such walls, even in a considerable period. Experience also shews us that in those places where there has been no fire, the cold which exhales from the walls is felt for a long time. As an additional confirmation of our view, we may mention that a pane of glass, although so exceedingly thin, is of the nature of stone; nevertheless, owing to its thinness, no cold exhales from it. In like manner, there is much less cold in a thin piece of ice than in a thick block. Hence, if the walls were built only a single brick in thickness, the room would be warmer than if they were constructed of the most enormous stones.

III. The greater the surface of the timber walls in proportion to the space, the warmer is the room; which is a necessary consequence of the preceding facts. Hence, a square room is warmer than a round one; an oblong, warmer than a square; and the more oblong it is, the warmer does it become.

The greater the space on the floor and walls which the fire in the stove can occupy with its rays, or heat, the warmer will the apartment be. Consequently, low rooms are warmer than lofty ones, because there is both much surface to little space, and the heat does not rise so high; for it is about the ceiling that the warmth accumulates. The contrary holds good in buildings with bare stone walls.

IV. The heat will be well preserved in an apartment in proportion as the upper parts of the roof and ceiling are well closed, compact, and free from crevices. The heat flows out like a stream; but it will not escape, if the cracks are in the lower parts of the room, its tendency being to ascend, not descend. Hence, no heat passes out through the lower openings, but the external wind and cold enter thereby, and by their pressure drive the heat through the upper parts. Hence the rule, that the fewer chinks there are in the upper part of a house, or the more compact it is, the better.

The farther a crevice is from the ceiling, the less prejudicial it is, and the less heat escapes through it, but the contrary in proportion as it is near the ceiling.

The loftier the windows, and the less their distance from the ceiling, the more difficult is it to maintain the warmth of the room, and *vice versâ*. A large gap in the floor will frequently be found to occasion no loss of heat.

Attention should be paid, therefore, to the following points. 1. The joints and angles in wooden houses must be well made, and accurately fitted to each other. 2. The joinings in the roof throughout must be carefully stopped up. 3. The stove must shut well; that is, the plates must be fitted to the opening, without leaving any gaps. 4. There must be no aperture in the upper part of the window. 5. Nor in the upper part of the door. 6. It is best, therefore, to have double doors and windows. 7. Doors communicating with a cellar, or with the lower part of the house, admit a large quantity of cold air, and cause a draught in the adjoining rooms.

V. For the method of heating by stoves, and of maintaining the warmth for a very long time without much consumption of fuel, the reader is referred to our *New Construction of Stoves*.*

Liège, November 29th, 1721.

An Elucidation of a Law of Hydrostatics, demonstrating the Power of the deepest Waters of the Deluge, and their Action on the Rocks and other Substances at the bottom of their Bed.

In a former Treatise,† published in Swedish, I endeavoured to demonstrate from the laws of hydrostatics, that rocks of great bulk may have been torn from their places in the bed of the deepest waters of the deluge, and scattered over the land; as we find to be the case in the northern countries especially. But, to place the truth of this assertion in a clearer light, we shall now explain the rules to which we have alluded above.

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* New Observations and Discoveries respecting Iron and Fire, and particularly respecting the Elemental Nature of Fire; together with a new Construction of Stoves, in *Some Specimens of a Work on the Principles of Chemistry*, p. 206, 8vo., London, 1847.

† *Om Wattnens Hoegd*, &c. (See note, p. 150.)

Let AB be a vessel, or other receptacle, full of water; let *a* be a stone, or other massive body heavier than water, lying at its bottom, and let D be a column of water above it. It is well known, from hydrostatic principles, that, 1. The stone *a* is pressed on every side by the water. 2. This pressure is according to the height of the column of water. 3. According to this height, the stone is pressed in every direction, upwards, downwards, and laterally. 4. If the body *a* be set in motion, with a volume of the water; as for example, if it be a piece of timber, or the trunk of a tree, which exactly obeys the motion of the water, so that it is carried with the same velocity as the volume itself, it follows from thence, that the water nevertheless presses according to its height, both upwards and downwards, as well as towards the sides. The reason of this is clear; for the mass which obeys the motion of the volume of water, must be considered as in equilibrium, and its pressure by the water is the same, as if both itself and the water were at rest. 5. But here the reader will ask, whether the pressure of the water will be equal on every side of the stone, if the volume of water DDD be in motion, whilst the stone *a* is at rest at the bottom? Let the volume of water flow from *m* to *n*, whilst the mass *a* remains quiescent; we maintain, that in this case, there is a greater pressure on the above-mentioned mass *a* at the side *m*, than at the side *n;* for if the water flows from *m* towards *n*, the force of its pressure, together with the volume from *m*, decreases towards *n;* so that it is diminished in *n* as much as it is increased in *m*. We have ocular demonstration of this fact in every body of water in violent agitation; for if it strike against any quiescent object, as from *m* towards *n*, a sort of sinking of the water appears around *n*, or rather, it is like an empty space, which resembles either a hyperbolic or triangular cone. This is more evident in proportion as the force of the water is violent; when, therefore, we see that the water endeavours to escape from the part *n*, (since it is driven with rapidity, or requires time before it can return,) it is manifest that the pressure of the water must be diminished on the side *n*, whilst on the side *m* it remains, and is even increased. 6. Therefore, when the water is impelled against a heavy, quiescent body, it follows that the pressure or impulse will be in proportion to the height of the column of water. For the water presses according to the height of the column; and as, in the example before us, this pressure exists on one side only, and not equally on the other, from which the water is striving to escape, the ratio of pressure is according to the height of the water.

From these data we have grounds for our opinion, that the stones and fragments of rocks in the bed of the waters of the Deluge might have been moved hither and thither with the water; and that after having been torn from their hills, they were carried into the plains; whence in some places the country is scattered over with them; in others ridges are formed, (of which a great number may be seen in Sweden,) and here and there the crust of the earth has been rendered uneven. This effect is also seen in dams, or water dykes, constructed of stones: if the height of the water is only a single ell, the stones remain in their places; but if it rises three or four ells, they are immediately torn from their site, and carried away by the stream. An effect of the same principle may also be seen in the smelting works, sometimes called *puchwerck,)* where the ores are beaten with hammers, and when pulverized, they pass into the lower canals, and we find that pieces of stone of no small size are carried for a considerable distance towards the lowest part of the canal, and frequently into the very pits. A similar result may be observed in the air, or at the bottom of our atmosphere, if the wind or volume of air strike against any plane surface, or if the latter be projected into the air, the force and resistance increase according to the velocity; all which effects may be considered as occasioned by the same causes. Many additional facts might be adduced in support of our position, should those already mentioned prove insufficient.

We have lately perused a little book published at Leipsic, under the title of *The History of Learning.** The authors, who are anonymous, have directed their pens against our *Miscellaneous Observations,* especially noticing the typographical errors, and objecting to the above-mentioned law of hydrostatics, as well as to our opinion respecting mathematical points;

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* This *Historie der Gelehrsamkeit* has long since been consigned to oblivion.

on which subjects, God willing, we shall speak elsewhere. But in their preface, these writers tell us that they are anonymous, that they have no director, no chief, no law among them; that one contributor is not acquainted with another, and that nevertheless, without the assistance of inspiration, as they say, they bring forth a yearling volume under the above title. Who, or what they are, is no affair of ours: but, as they are anonymous, and without law or leader, in order without danger to themselves to lie in ambush for travellers, so we would have them know, that we consider it neither seemly nor advisable to challenge them to any sort of contest whatever*.

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* From the *Acta Literaria Sveciæ*, vol. I., 1721, pp. 353—356.

THE END.

BIOGRAPHICAL NOTICES OF AUTHORS

MENTIONED IN THE PRECEDING OBSERVATIONS.

Boyle, Robert, born in 1626; died in 1691. (See *Principles of Chemistry*, p. 243.)

Bresmal, Jean François, a French physician, flourished towards the end of the seventeenth and beginning of the eighteenth century. The works to which Swedenborg alludes, are the "Hydro-Analyse des Minerales chaudes et froides de la Ville Imperiale d'Aix-la-Chapelle," &c., Liège, 1703, 12mo.; and "La Circulation des Eaux, ou l'Hydrographie des Minerales d'Aix et de Spa," Liège, 1719, 12mo. Both of these works are well written for the time in which the author lived.

Bromell, Magnus von, a learned Swede, born at Stockholm, 1679, died March 26, 1731. He studied medicine in Holland, France, and England, and was on terms of intimacy with the principal scientific men in each of those countries. On his return to Sweden, he was admitted a member of the Royal College of Physicians; and in 1710, he was intrusted with the arrangement of the sanitary regulations to be adopted against the plague which ravaged Stockholm and the whole of Sweden. He was afterwards appointed Professor of Anatomy in Stockholm, President of the Royal College of Physicians, and principal Physician to the King of Sweden. He collected a very excellent museum, consisting of coins, minerals, fossil remains, anatomical and pathological preparations, &c. A description of this museum is given in the *Acta Literaria Sveciæ* for 1736, p. 208. In his "Lithographia Svecana, Upsala, 1726," he mentions and confirms several of Swedenborg's geological researches. A German translation of this work was published in 1740.

Hauksbee, Francis, an English physician of the seventeenth century, celebrated for his researches in various branches of natural philosophy, especially on light and electricity. He published an account of his discoveries in his "Physico-Mechanical Experiments on various subjects; London, 1709," 4to. An edition in 8vo. also appeared in 1719.

Helwig, or Helwing, George Andreas, a mineralogist and botanist, born at Angerburg, in Prussia, in 1666; died in 1748. He delivered public lectures on his favourite sciences at Jena with great success: but afterwards he entered the church. The "Lithographia Angerburgica" was published in 1717—1720, at Kœnigsberg, in 2 vols., 4to., with numerous plates. He also published the "Flora Prussica," 4to., in 1712, with a supplement, in 1726; a treatise on Stones and Fossils, in 1717; and the "Flora Campana," 4to., with 12 plates, in 1719.

Hessel, or Hesselius, John, a Swedish physician and mineralogist: he accompanied Swedenborg in some of his travels. His researches on the mineral treasures of Sweden are very interesting, and are mentioned with great commendation in the "Acta Literaria Sveciæ," 1721, p. 184. He enriched the University of Upsala with numerous additions to its museum, and contributed several valuable papers to the Transactions of the Academy of Sciences of Stockholm, of which he was a member. He died in 1752.

A Melle, Jacob, a learned historian and numismatist, born at Lubeck in 1659, died in 1743. He travelled in England, France, and Holland, and corresponded with most of the learned in his times. On his return to Lubeck he entered the church. He published several works on history, numismatics, geological formations, fossil remains, &c. In his treatise, "De Lapidibus figuratis agri litorisque Lubicensis," published at Lubeck in 1720, 4to., he mentions Swedenborg's dissertation, "Om Wattnens Hoegd, &c.,"* in favourable terms.

Newton, Sir Isaac, born at Woolstrop, in Lincolnshire, Dec. 25th, 1642; died March 20th, 1727. His great work, the "Principia," was published in 1687, and the "Optics" in 1704.

Polhem, Christopher. (See *Principles of Chemistry*, page 244.)

Roberg, Laurence, a Swedish physician and mineralogist, born in 1664, died in 1742. He was appointed Professor of Medicine in the University of Upsala, and was a liberal contributor to its museum. He published his "Positiones Medicæ, Lugd. Bat. 1693," in 4to., "Grundvahl til plantekjænningn, Upsala, 1730," in 12mo., and several other works, in Latin and Swedish. He was likewise a contributor to the "Dædalus Hyperboreus."

Rudbeck, Olaus, a very learned Swede, was born at Westeras in Westmanland, in 1630, and died at Upsala in 1702. He was professor of anatomy and botany in the University of Upsala, and published several works on those sciences. The work to which Swedenborg alludes, is his "Atlantica, sive Manheim, vera Japheti posterorum sedes ac patria, Upsala, 1675-6," in four volumes folio, Swedish and Latin, with plates. It is a curious and learned work. His son, of the same name, was also distinguished for his learning, and published several works.

* See note, p. 130.

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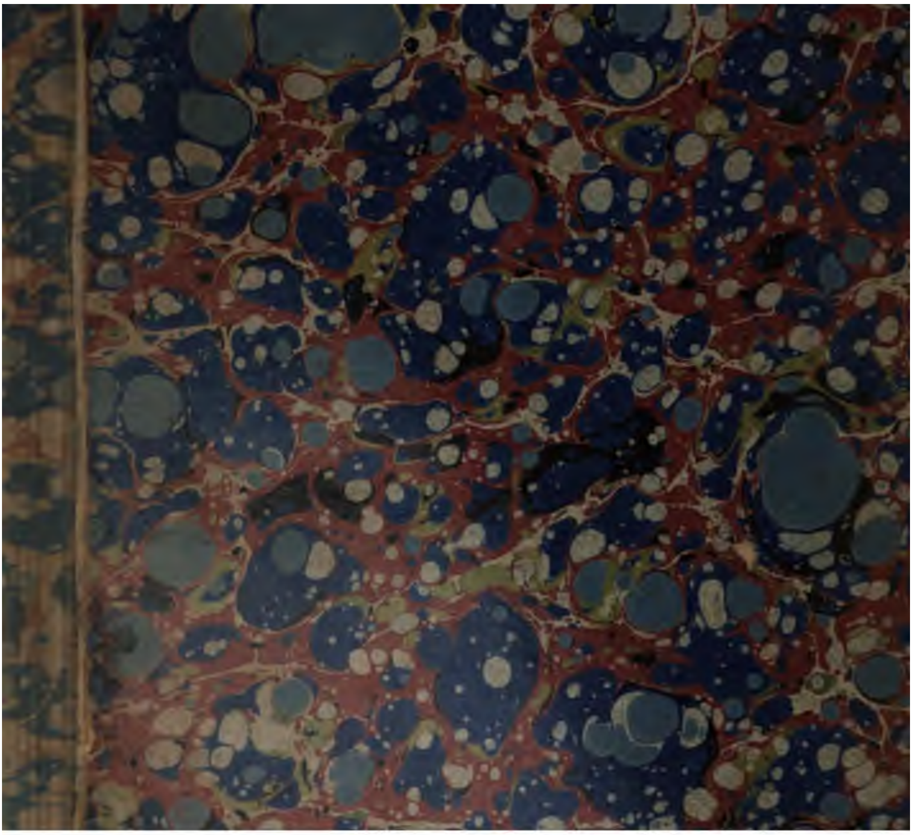

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